

Final report

OWMC
Ontario
Waste Management
Corporation

A provincial crown corporation



 **Monenco**

SITE SELECTION PROCESS
PHASE 4A
SELECTION OF A PREFERRED SITE(S)

Engineering

Prepared by
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MAY 1986



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Gentlemen:

OWMC Treatment Facility
Monenco Contract No.: MNC 8084-2

Input to Site Selection
Site Selection Process, Phase 4A:
Selection of Preferred Site(s) - Engineering

We are pleased to submit herewith the report entitled: "Site Selection Process, Phase 4A: Selection of Preferred Site(s) - Engineering".

This report documents the various engineering inputs to the site selection process. It includes facility characteristics information provided to other members of the site selection team for their analyses, and also the results of technical and economic analyses conducted by Monenco for site selection purposes.

We trust that this report meets the Corporation's requirements.

Yours very truly,

R. A. Grant
Project Manager

GGB/rh
Encl.

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PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS

EXECUTIVE SUMMARY

1. PURPOSE OF THE REPORT

Facility development and design studies were carried out by Monenco Limited in support of Phase 4A of Ontario Waste Management Corporation's (OWMC) Facilities Development Process. Phase 4A is described in OWMC's report "Facilities Development Process. Phase 4A report" (Ref: OWMC²³) and in M.M. Dillon Limited's report "Site Selection Process. Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD¹⁶).

The purpose of this report is to supplement the report "Site Selection Process. Phase 4A: Selection of preferred Site(s) - Site Selection" (Ref: MMD¹⁶) by documenting the engineering input to the site selection process of Phase 4A. This documentation included the following:

- General characteristics of the proposed treatment and disposal Facility capable of processing up to 300 000 tonnes/annum (t/a) of liquid industrial and hazardous wastes (special wastes). The characteristics are referred to in this report as Facility Characteristics Information (pp 24 to 51).
- Gaseous emissions associated with normal facility operation, upset or abnormal operating conditions and potential on-site accident scenarios for use in the assessment of health risks (p. 30).

- Engineering input to the refinement of siting options¹ analysis which:
 - refined site boundaries at candidate sites LF-3C, LF-1E and PI-1N (pp 53, 54),
 - identified the preferred access routes from the 400 series highways to each siting option and the intersite transfer routes between siting options (p. 55),
 - reviewed the feasibility and selected a preferred route for a rail spur to each site (p. 55), and
 - selected the preferred location of the physical/chemical treatment plant at each partially integrated siting option (pp 56 to 60, 67).
- Engineering adaptations specific to each site which were developed for, or as an outcome of, the basic acceptability analysis, mitigation of constraints and areas of concern identified by other members of the site selection team, and to take into account the variable and constraining features at each candidate site (pp 68 to 86).
- Preliminary capital and operating cost estimates for each siting option (pp 87 to 103).
- Comparative evaluation of siting options, including an assessment of achievable landfill life (pp 105 to 110), a ranking of siting options based on cost considerations (pp 110 to 117) and a sensitivity analysis to test the assumptions used to establish the ranking of siting options (pp 118 to 135).

¹ Siting option refers to the combination of candidate sites required to accommodate the treatment and disposal technologies that OWMC's proposed Treatment Facility would utilize to treat special waste and dispose of solidified residues. An integrated siting option consists of the engineered landfill, the physical/chemical treatment plant (including solification) and the incineration plant all located on one candidate site. A partially integrated siting option consists of a combination of two candidate sites, with the engineered landfill located on the LF site, the incineration plant located on the PI site and a choice of locating the physical/chemical treatment plant (including solification) on either candidate site.

2. SCOPE AND METHOD

Design development for the proposed Facility is an ongoing process which is proceeding in parallel with and beyond the activities to select a preferred site(s) as part of Phase 4A of OWMC's Facilities Development Process. Engineering data, developed for the purposes of site selection, are therefore preliminary. Greatest attention was given to those facility characteristics which are most important in the comparative evaluation of siting options, so as not to understate possible risks to human health, environmental impacts or costs.

The Phase 4A site selection process was based on the Facility operating at its maximum potential capacity of 300 000 t/a by the year 2000, and using a mode of operation where all the liquid effluent from the treatment processes is solidified and disposed of in an engineered landfill. This mode of operation is referred to in this report as "Total Solidification".

During Phase 4A, methods other than total solidification for the disposal of liquid effluent were identified (Ref: OWMC²³). These were evaluated as part of the Phase 4A site selection process by means of an overview analysis, which determined that none of the siting options under consideration would constrain the selection of any of the effluent disposal options (Ref: MMD¹⁶). Given this situation, OWMC directed that "Partial Solidification with Evaporation", which involves the evaporation of effluent which is then discharged to atmosphere via a stack, was to be considered by each member of the site selection team as part of a sensitivity analysis, to determine whether this choice of effluent disposal option would affect the ranking of siting options (pp. 136 to 149).

During Phase 4B, the technical feasibility of evaporation and/or total solidification will be further evaluated.

2.1 SCOPE

The following scope of work was established to meet the requirements of the engineering input to the Phase 4A site selection process:

- Develop and provide to the site selection team, facility characteristics information (pp 24 to 51) on :
 - Construction of the Facility:
 - Initial Facility (150 000 t/a Capacity), and
 - Expanded Facility (300 000 t/a Capacity).
 - Operation of the Facility:
 - Emissions and effluents,
 - Engineered containment,
 - Transportation requirements,
 - Anticipated noise levels,
 - Candidate sites, technical buffer zones and layouts,
 - Visual appearance and lighting,
 - Dust,
 - Hours of operation,
 - Employment levels,
 - Services for the Facility, and
 - Taxation and zoning.
- Define the gaseous emissions which could potentially be discharged from the Facility during normal operation, upset conditions and on-site accidents; as engineering input to the generic risk assessment for use in the assessment of health risks (p. 30).
- Establish the potential events for leaks and spills on-site for use in the hydrogeologic comparative evaluation of siting options (p. 31).
- Provide engineering input to the refinement of siting options analysis which, for the comparative evaluation, established:
 - site acquisition boundaries of LF-3C, LF-1E and PI-1N (pp 53, 54),
 - preferred access roads (p. 55),
 - feasibility and selection of rail access (pp 55, 56), and

- location of the physical/chemical treatment plant for partially integrated siting options involving the location of facility components on two sites (pp 56 to 60, 67).
- Modify or adapt the engineering design specific to each site for, or as an outcome of, the basic acceptability analysis, to mitigate constraints and areas of concern identified by other members of the site selection team, and to take into account the variable and constraining features at each candidate site (pp 68 to 86).
- Estimate capital and operating costs (pp 87 to 103) and evaluate these costs over the life of the Facility for each siting option (pp 110 to 117).
- Perform a comparative evaluation of siting options, including a discussion of the landfill life achievable and rank the siting options based on cost considerations (pp 105 to 117).
- Test the assumptions used in the comparative evaluation by performing a sensitivity analysis to examine the effects of:
 - changing the economic inputs and assumptions used in the economic analysis (pp 118 to 120),
 - transporting additives and reagents to site by rail versus road (p. 121),
 - changes to site size at candidate sites LF-3C and LF-1E (pp 122 to 124),
 - use of partial solidification with evaporation rather than total solidification for the disposal of treated effluent (pp 122, 125), and
 - engineering flexibility differences which may affect facility design or facility layout options (pp 126 to 135).

2.2 METHOD

The Site Selection Process, Phase 4A: Selection of Preferred Site(s), was conducted by a multi-discipline team of consultants in which Monenco Limited, as a member and as OWMC's engineering consultant, provided engineering input to the process formulated by the site selection coordinating consultant, M.M. Dillon Limited (Ref: MMD16) in consultation with the site selection team.

The methodology involved four distinct steps as follows:

- Step 1 - Factor Identification; to assist in the comparative evaluation of siting options.
 - Data Collection and Analysis; to obtain information specific to each siting option, establish facility characteristics information input to the basic acceptability analyses and incorporate constraints identified by the site selection team.
- Step 2 - Refinement of Siting Options; as required to further define the characteristics of each candidate site.
- Step 3 - Comparison of Siting Options; to examine the achievable landfill life, the overall life cycle costs for each siting option, and to rank siting options on the basis of cost.
- Step 4 - Conclusions and Recommendations; from an engineering perspective based on the results of the assessment of landfill life and the ranking of siting options on the basis of cost.

The approach adopted was as follows:

- Adopt the preliminary facility design described in the "Status Report Facility Design" (Ref: MONENCO¹⁹) as a conceptual design basis for the purpose of site selection.
- Extrapolate preliminary design data based on an initial facility capacity of 150 000 t/a, to estimate the characteristics and components of an expanded Facility having an ultimate capacity of 300 000 t/a.
- Develop a "worst case", which represents extreme conditions that could be associated with the Facility design and operation (p. 25), for the purposes of establishing the facility characteristics information, in order that the Phase 4A site selection process would not understate the risks to human health, environmental impacts or costs.
- Determine for each siting option potential sources for provision of utility services such as water, electric power, telephone, sewers etc. to the candidate sites by liaising with local and regional agencies where appropriate.

- Address how specific constraints and areas of concern identified by other members of the site selection team, resulting from their basic acceptability analyses or comparative evaluation, could possibly be mitigated by engineering design modifications, and adjust the facility characteristics information to reflect agreed changes to mitigate such concerns or constraints.
- Identify the major factors to be used in evaluating the differences and similarities of locating OWMC's Facility on the siting options and subdivide the factors into indicators as a more precise way of identifying, describing and predicting costs and engineering concerns in accordance with the general approach adopted for site selection (Ref: OWMC²² and MMD¹⁶).
- Compare siting options on the basis of landfill life estimates (p. 111) and costs (pp 95, 102) and rank siting options on the basis of an economic analysis of the capital and operating costs over the assumed 20 year life of the Facility (p. 117).
- Test the assumptions used to rank siting option by means of a sensitivity analysis (pp 118 to 135).

3. PREMISES AND POSTULATES

3.1 PREMISES

Engineering data, developed for the purposes of site selection in Phase 4A and documented in this report, are based on the following premises established by OWMC:

- Goals established by OWMC to guide the site selection process, in order of importance, as follows:
 - minimize risk to human health,
 - minimize environmental impact, and
 - minimize financial cost to OWMC and the people of Ontario.
- OWMC Facilities, no matter how large or small they ultimately may be, must be designed to handle all types of special waste.

- These wastes must undergo treatment to the fullest extent possible, using the world's best proven technologies, prior to the safe disposal of the remaining treated residues.
- The Facility will consist of a high-temperature thermal destruction system (rotary kiln incinerator), physical/chemical treatment processes including solidification, and an engineered landfill.
- An engineered landfill of the conventional type was assumed for the purpose of site selection. This does not preclude the selection of other types of landfill still under consideration (Ref: MONENCO¹⁹).
- Treated effluent from the physical/chemical treatment plant is solidified and disposed of in the engineered landfill. This does not preclude the selection of alternative means of effluent disposal still under consideration (Ref: OWMC²³).
- Build up of waste quantities to be treated at OWMC's Facility, in a staged manner to 150 000 t/a in year 5 and 300 000 t/a in year 10 of operation (see Figure 6.1 p. 113).
- Initial capacity of the Facility to be 150 000 t/a expanding to 300 000 by year 5 of operation to meet increased waste build up.
- Facility design capacities and operating hours as follows:
 - One 30 000 t/a rotary kiln incinerator for initial facility capacity with a second unit of equal size for ultimate capacity, operating 7000 hours/year, 24 hours/day, 7 days/week.
 - One physical/chemical treatment plant, including solidification, capable of treating 50 000 t/a of inorganic waste when operating initially one shift/day, 5 days/week and 50 weeks/year, and capable of treating 120 000 t/a when operating 3 shifts/day rather than one. The physical/chemical treatment plant will be expanded to an ultimate capacity of 240 000 t/a and will then operate 3 shifts/day, 5 days/week and 50 weeks/year.
 - Engineered landfill operation, 250 days/year, 5 days/week, one shift/day rising to 3 shifts, but with no heavy equipment operating during night time hours. The landfill will only operate one shift/day where it is separate from the treatment facilities.
- Quantities and classification of special wastes as indicated in Appendix C.1.

- Facility to be placed on thick uniform clay-textured soils capable of providing natural containment, avoiding total reliance on engineered systems for containment.
- A technical buffer zone to be provided to maintain a distance of approximately 400 m between specific sources of potential fugitive emissions within the central operating area of the Facility, and OWMC's property boundary. A 50 m buffer zone is to be provided between the landfill area and the property boundary (Ref: MMD¹⁵).
- The comparative evaluation of siting options to be based on a 300 000 t/a Facility operating at full capacity by the year 2000.
- Facility life to be 20 years, for the purposes of economic evaluation and landfill capacity, with year 10 of operation being the calendar year 2000 A.D. for estimating costs and for risk/impact studies.
- The eight candidate sites and thirteen siting options, identified in Phase 3 (Ref: OWMC21), to be considered during Phase 4A for detailed comparative evaluation. The thirteen siting options are as follows:
 - Case 1 - Integrated Siting Option: Incineration plant, physical/chemical treatment (including solidification), and engineered landfill all on one site.
 - LF-9C (West Lincoln)
 - LF-3C (West Lincoln)
 - LF-1E (Niagara Falls)
 - Case 2 - Landfill Separate Siting Option: Incineration plant and physical/chemical treatment plant (including solidification) on the PI site, with the engineered landfill at the LF site.
 - LF-2N/PI-1N (Mississauga/Milton)
 - LF-2N/PI-13N (Mississauga/Milton)
 - LF-4N/PI-1N (Milton)
 - LF-4N/PI-13N (Milton)
 - LF-1E/PI-27E (Niagara Falls)

- Case 3 - Incinerator Separate Siting Option: Incineration plant on the PI site, with physical/chemical treatment plant (including solidification), and engineered landfill at the LF site.

PI-1N/LF-2N (Milton/Mississauga)

PI-13N/LF-2N (Milton/Mississauga)

PI-1N/LF-4N (Milton)

PI-13N/LF-4N (Milton)

PI-27E/LF-1E (Niagara Falls)

In May 1985, OWMC rejected candidate site LF-2N because it could not be relied upon to provide natural containment (Ref: MMD¹⁸). It has, therefore, not been included in the comparative evaluation documented in this report. This rejection resulted in the number of siting options for comparative evaluation being reduced to nine.

3.2 POSTULATES

The following assumptions were used in developing facility characteristics information:

- The physical form of the waste (e.g. pumpable liquid and sludges and non-pumpable solids and sludges) was estimated from waste data provided by OWMC and is presented in Table 2.1 (p. 46) and Appendix C.1.
- The quantity of special wastes to be delivered in 200 L (45 gal) drums was estimated to be 3%.
- Quantities of chemicals and reagents were estimated based on waste data provided by OWMC and assumed waste characteristics and contaminant concentrations and is presented in Table 2.2 (p. 47).
- A "Worst Case" which represents extreme conditions that could be associated with OWMC's Treatment Facility, was established from a number of scenarios that were developed so that the Phase 4A site selection process would not understate the risk to human health, environmental impacts or costs (p. 25).

These scenarios were based on the following assumptions:

- Conservatively low assumptions on the likely solids content of inorganic waste delivered to the Facility, resulting in maximum quantities of treated effluent requiring disposal.
- Minimum re-use of treated effluent in the Facility, thus increasing the likely quantities of effluent requiring disposal.
- Maximum quantity of leachate generated in the landfill.
- The leachate will require treatment, thus increasing the quantities of effluent requiring disposal.
- The above assumptions also maximize the estimates of additives and reagents required and the volume of solidified material to be land-filled, thereby resulting in conservatively low estimates of landfill life and high estimates of transportation quantities.
- Conservatively high estimates of incinerator stack emissions, plant fugitive emissions, spills and leaks occurring on the Facility and other process upsets or on-site accidents.

4. STATUS OF DATA

As previously mentioned, design development has proceeded in parallel with Phase 4A site selection and will continue through Phase 4B, to incorporate the following:

- Site specific design for the engineered landfill including selection of specific landfill type following completion of the biophysical field programs.
- Site specific arrangements for the central operating area, incorporating results of layout optimisation studies and engineering reviews by OWMC's technology and operations consultants.
- Finalized conceptual designs for the various process areas of incineration and physical/chemical treatment including solidification, following completion of site specific engineering and reviews by OWMC's technology and operations consultants.

- Adjustments to the facility design following site specific risk and impact assessment, to incorporate changes required to reduce constraints, concerns and impacts or to enhance potential benefits.
- The selected effluent disposal option.

The preliminary engineering that formed the basis for establishing facility characteristics information was of a level of detail such that the preliminary cost estimates produced are considered to have a level of accuracy within plus 30% and minus 18%.

While changes to the facility characteristics and cost may occur during finalisation of the facility design, it is not expected that these will be of a nature to effect the assessment of siting options conducted in Phase 4A.

Data from the following organizations were used in the development of the facility characteristics, site specific designs and cost estimates.

Chem-Technics Inc. (Sub-consultant to Monenco Limited)

- Solidification technology.

Environmental Elements Corporation, Von Roll Ltd., and
Hessische Industriemüll GmbH

- Incineration technology.
- Stack emissions.

Gartner Lee Associates Limited

- Constraints on landfill and foundation design.
- Source of raw water.
- Location of storm water discharge.
- Off-site drainage improvement cost estimates.

Graydon Rogers Appraisals Ltd. (Sub-consultant to Leon Kentridge Associates Limited)

- Land acquisition costs for the candidate sites.
- Land acquisition costs for access road improvement rights-of-way.

Local Municipalities and Utilities

- Availability of services (natural gas, water, electricity, telephone, storm sewers and sanitary sewers).
- Capital cost estimates for connection to services.
- Rates for use of services.

M.M. Dillon Limited

- Transportation cost estimates for special waste, intersite transfers and additives and reagents.
- Capital cost estimates for off-site access road improvements.
- Access road improvement right-of-way land requirements.

M.M. Dillon Limited. (Sub-consultant to Monenco Limited)

- Landfill characteristics.
- Landfill life estimates.
- Landfill capital and operating cost estimates.

Museum of Indian Archaeology (London, Ont.). (Sub-consultant to Gartner Lee Associates Limited)

- Cost estimates for excavation of archaeological resources.

Ontario Research Foundation

- Incinerator stack flue gas exit velocity and evaporator stack height.

5. MAIN FINDINGS

The main findings of this report are achievable landfill life (p. 152), estimated facility cost for each of the siting options (pp 153 to 155) and the minimal effect on the ranking of siting options resulting from the sensitivity analysis (pp 155, 156).

5.1 LANDFILL LIFE

When operating under the total solidification mode, where all the treated effluent is solidified and disposed of in the engineered landfill as a solidified mass, none of the siting options satisfy OWMC's criterion for a minimum twenty year landfill life. The achievable lives range from 11 years at LF-1E/PI-27E to 19 years at LF-3C (Table 6.1 p. 111) based on the premises (pp vii to x) and postulates (pp x, xi) established for site selection including conventional landfill design. All other siting options fall within this range.

Introduction of an alternative option for effluent disposal, partial solidification with evaporation, where the treated effluent is evaporated to atmosphere and only the remaining treated residues are solidified and landfilled, results in an increase in landfill life. The landfill lives under this mode of operation range from 19.5 years at LF-1E/PI-27E to 32.5 years at LF-3C (Table 7.5 p. 147) based on the premises and postulates established for site selection, including conventional landfill design. All other siting options fall within this range.

5.2 COST

Of the total estimated capital cost for the proposed 300 000 t/a OWMC Treatment Facility, on average, 89% is common to all siting options and 11% is specific to each siting option (Figure 5.1 p. 96). This capital cost, expressed in 1984 dollars, ranges from \$189 533 000 at LF-3C to \$194 000 000 at LF-1E/PI-27E (Table 5.1 p. 95). The annual operating cost, when treating 300 000 t/a of a special waste, ranges from \$42 295 000 at LF-4N/PI-1N to \$46 398 000 at LF-1E/PI-27E (Table 5.2 p. 102). All other siting options fall within this range.

The economic analysis over a 20 year operating period results in a total cost expressed in 1984 dollars (present value of life cycle annual costs) which varies only 7% between the siting options, ranging from \$567 million at

LF-4N/PI-1N to \$606 million at LF-1E/PI-27E (Table 6.3 p. 117). This analysis gives the following ranking of siting options on a cost basis:

<u>Siting Option</u>	<u>Cost Order</u>	<u>Ranking</u>
LF-4N/PI-N	1 (lowest cost)	1
LF-4N/PI-13N	2	2
LF-9C	3	3
LF-3C	3	3
LF-1E	4	4
LF-1E/PI-27E	5 (highest cost)	5

When partial solidification with evaporation is introduced, the total estimated capital costs increase slightly, ranging from \$194 293 000 at LF-3C to \$197 415 000 at LF-1E/PI-27E (Table 7.3 p. 145). Conversely, the annual operating costs reduce, mainly due to a decrease in the requirement for solidification reagents, ranging from \$36 386 000 at LF-4N/PI-1N to \$38 607 000 at LF-3C (Table 7.4 p. 146). All other siting options fall within this range.

Due to the smaller capital cost differential between siting options under partial solidification with evaporation, and also to the decrease in annual operating costs, the economic analysis results in a present value of lifecycle annual costs which varies less than 4% between siting options, ranging from \$524 million at LF-4N/PI-1N to \$544 million at LF-9C (Table 7.6 p. 148). The ranking of siting options for this mode of operation becomes:

<u>Siting Option</u>	<u>Cost Order</u>	<u>Ranking</u>
LF-4N/PI-1N	1 (lowest cost)	1
LF-4N/PI-13N	2	2
LF-1E	3	3
LF-1E/PI-27E	4	4
LF-3C	4	4
LF-9C	5 (highest cost)	5

5.3. SENSITIVITY ANALYSIS EFFECTS ON RANKING

Sensitivity analyses were conducted as part of the comparative evaluation process to test the assumptions used in the economic analysis. The results of the sensitivity analyses show that the following variations have minimal effect on cost ranking:

- Changing the economic inputs and assumptions used in the economic analysis.
- Transporting additives and reagents to site by rail.
- Changes to the site size at candidate sites LF-3C and LF-1E.
- Use of partial solidification.

In respect of engineering flexibility (pp 126 to 135), it was determined that different siting options exhibited differing flexibility in being able to accommodate the various options being considered by OWMC and provide a greater degree of freedom to the engineer (Monenco Limited) to produce the optimal design (Table 6.8 p. 135).

However, although the differences in flexibility between siting options are not viewed as a major constraint to OWMC or their engineer in finalizing a satisfactory conceptual design for the preferred site(s), LF-3C and LF-9C are ranked higher than the other siting options due to their ability to accommodate all three of the landfill types under consideration (pp 127, 129) and the relative ease with which their landfill areas can be expanded (pp 133, 134).

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the small cost differences between siting options resulting from the economic analysis, expressed in percentage terms (pp. 153, 154), and taking into account the preliminary nature of the capital and operating cost estimates, Monenco recommends that the cost factor be given low importance in

the selection of a preferred site(s). This is also consistent with OWMC's Corporate goals with cost being rated of lower importance than matters dealing with human health and environmental impacts.

There is considerable variation in landfill lives between siting options and in the case of total solidification, none of the siting options achieve OWMC's objective of twenty years. The introduction of partial solidification with evaporation as the alternative effluent disposal option improves the landfill lives such that all of the siting options substantially meet or better twenty years of landfill life based on the premises and postulates established for Phase 4A.

However, several factors discussed in Part 4 of this Executive Summary can influence the landfill life which may be expected at any siting option, due to any or a combination of these factors, but particularly:

- Method of effluent disposal option selected in Phase 4B.
- Type of engineered landfill design selected in Phase 4B.
- Variation in the actual quantities and characteristics of special waste to be treated at the Facility as well as the rate of build up of special waste with time.
- Specific details of the engineered landfill design.

In addition, the engineering flexibility analysis (pp 126 to 135) indicates that although the considerable variations between siting options (in terms of engineering flexibility) are not considered as a major constraint in finalizing a satisfactory conceptual design, some of the siting options preclude the option for shallow entombed landfill and/or restrict the potential for expansion of landfill area should a need be identified at some future date. From a flexibility basis, LF-3C which provides the most flexibility is ranked first with LF-9C a close second and the remaining siting options all ranked equal third.

We recommend that the achievable landfill life be re-examined in Phase 4B for the preferred site(s), once the method of effluent disposal, type and details of the landfill design have been determined.

CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THE REPORT

Facility development and design studies were carried out by Monenco Limited in support of Phase 4A of Ontario Waste Management Corporation's (OWMC) Facilities Development Process. Phase 4A is described in OWMC's report "Facilities Development Process. Phase 4A Report" (Ref: OWMC23) and in M.M. Dillon Limited's report "Site Selection Process. Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD16).

The purpose of this report is to supplement the report "Site Selection Process. Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD16) by documenting the engineering input to the site selection process of Phase 4A. This documentation includes the following:

- General characteristics of the proposed treatment and disposal Facility capable of processing up to 300 000 tonnes/annum (t/a) of liquid industrial and hazardous wastes (special wastes). The characteristics are referred to in this report as Facility Characteristics Information (pp 24 to 51).
- Gaseous emissions associated with normal facility operation, upset or abnormal operating conditions and potential on-site accident scenarios for use in the assessment of health risks (p. 30).

- Engineering input to the refinement of siting options¹ analysis which:
 - refined site boundaries at candidate sites LF-3C, LF-1E and PI-1N (pp 53, 54),
 - identified the preferred access routes from the 400 series highways to each siting option and the intersite transfer routes between siting options (p. 55),
 - reviewed the feasibility and selected a preferred route for a rail spur to each site (p. 55), and
 - selected the preferred location of the physical/chemical treatment plant at each partially integrated siting option (pp 56 to 60, 67).
- Engineering adaptations specific to each site which were developed for, or as an outcome of, the basic acceptability analysis, mitigation of constraints and areas of concern identified by other members of the site selection team, and to take into account the variable and constraining features at each candidate site (pp 68 to 86).
- Preliminary capital and operating cost estimates for each siting option (pp 87 to 103).
- Comparative evaluation of siting options, including an assessment of achievable landfill life (pp 105 to 110), a ranking of siting options based on cost considerations (pp 110 to 117) and a sensitivity

¹ Siting option refers to the combination of candidate sites required to accommodate the treatment and disposal technologies that OWMC's proposed Treatment Facility would utilize to treat special waste and dispose of solidified residues. An integrated siting option consists of the engineered landfill, the physical/chemical treatment plant (including solidification) and the incineration plant all located on one candidate site. A partially integrated siting option consists of a combination of two candidate sites with the engineered landfill located on the LF site, the incineration plant located on the PI site and the choice of locating the physical/chemical treatment plant (including solidification) on either candidate site.

analysis to test the assumptions used to establish the ranking of siting options (pp 118 to 135).

The facility characteristics information was developed for the purpose of site selection and provided to other members of the site selection team to establish a basis for their comparative assessment of alternative facility siting options. Information was provided on:

- Construction of the Facility:
 - Initial Facility (150 000 t/a Capacity), and
 - Expanded Facility (300 000 t/a Capacity).
- Operation of the Facility:
 - Emissions and effluents,
 - Engineered containment,
 - Transportation requirements,
 - Anticipated noise levels,
 - Candidate sites, technical buffer zones and layouts,
 - Visual appearance and lighting,
 - Dust,
 - Hours of operation,
 - Employment Levels,
 - Services for the Facility, and
 - Taxation and zoning.

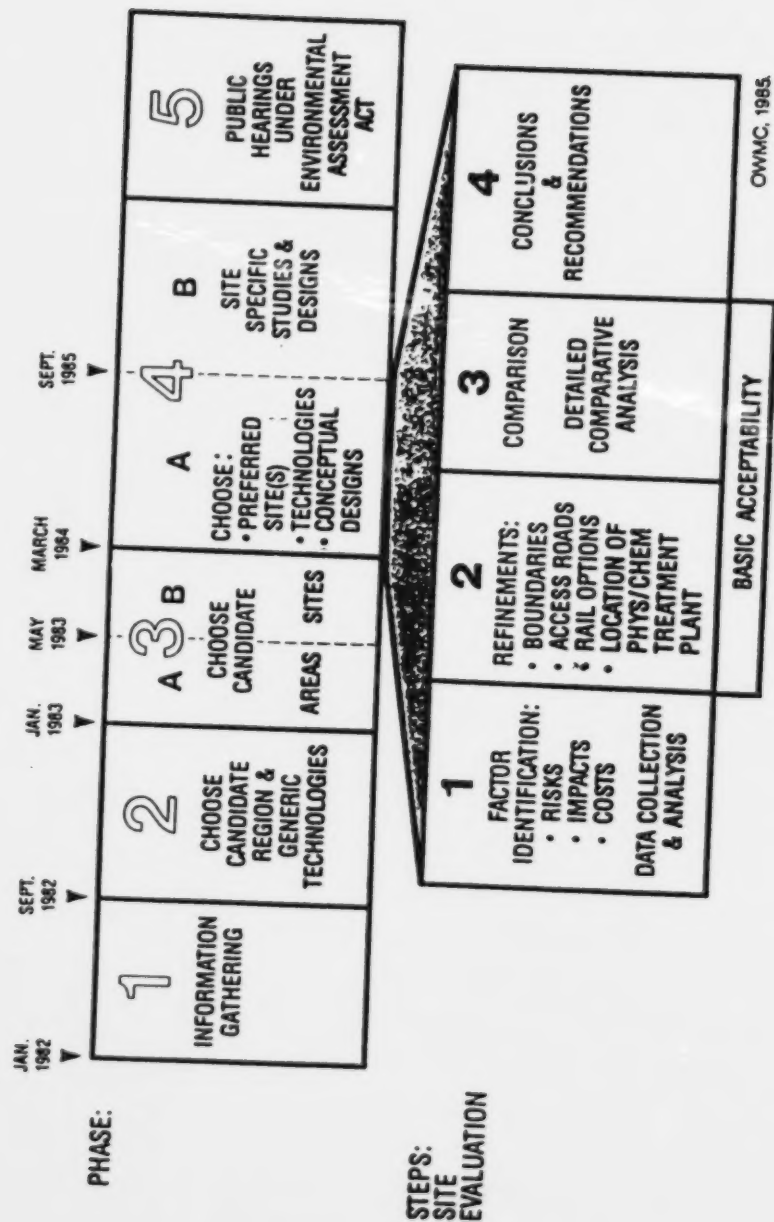
1.2 BACKGROUND INFORMATION

In 1982, OWMC embarked on a five-phase Facilities Development Process leading to the establishment and operation of a special waste treatment and disposal system for Ontario (see Figure 1.1).

Phases 1, 2 and 3 involved gathering information, deciding on appropriate waste treatment process technology, selecting a geographic region

FIGURE 1.1

FACILITIES DEVELOPMENT PROCESS



and twenty candidate areas within that region potentially capable of siting the Facility, studying 152 potential site areas and 16 potential sites and finally selecting eight candidate sites for further study. Phase 4A involved selection of a preferred site(s) from the eight candidate sites, while Phase 4B will involve more detailed study of the preferred site(s). The final phase of the Facilities Development Process, Phase 5, will be OWMC's environmental assessment submission under the Environmental Assessment Act of Ontario, on the location and design of a special waste treatment Facility.

Phase 3 of the Facilities Development Process (Ref: OWMC²¹) identified the following:

- The goals established to guide the site selection process, in order of importance, as follows:
 - minimize risk to human health,
 - minimize environmental impacts, and
 - minimize financial costs to OWMC and the people of Ontario.
- Eight candidate sites which were to be subject to detailed comparative evaluation in order to select a preferred site or sites.
- Three technologies (incineration, physical/chemical treatment including solidification and an engineered landfill) that OWMC's proposed treatment Facility would utilize to treat special waste and dispose of solidified residues.
- The location of each candidate site and their suitability to accommodate the technologies selected by OWMC, as identified on Figure 1.2.
- Thirteen siting options to be considered for detailed comparative evaluation during Phase 4 as follows:
 - Case 1 - Integrated Siting Option: Incineration plant, physical/chemical treatment plant (including solidification), and engineered landfill all on one site.
 - LF-9C (West Lincoln)
 - LF-3C (West Lincoln)
 - LF-1E (Niagara Falls)



Legend

- Candidate Site
- Regional Municipal & County Boundaries
- Township, Town & City Boundaries

LF Landfill

PI Physical/Chemical Treatment Plant & Incineration

Source: Ontario Waste Management Corporation. March, 1984.
Note: Symbols indicate location only, and not size or shape of sites.

Site Name	Landfill	Physical/ Chemical	Incinerator	
LF-2N	•	•		
LF-4N	•	•	•	Site
PI-1N		•	•	
PI-13N		•	•	
LF-3C	•	•	•	Integrated
LF-9C	•	•	•	Integrated
LF-1E	•	•	•	Integrated
PI-27E		•	•	

FIGURE 1.2
LOCATION OF
CANDIDATE SITES

- Case 2 - Landfill Separate Siting Option: Incineration plant and physical/chemical treatment plant (including solidification) at the PI site, with the engineered landfill at the LF site.
 - LF-2N/PI-1N (Mississauga/Milton)
 - LF-2N/PI-13N (Mississauga/Milton)
 - LF-4N/PI-1N (Milton)
 - LF-4N/PI-13N (Milton)
 - LF-1E/PI-27E (Niagara Falls)
- Case 3 - Incinerator Separate Siting Option: Incineration plant at the PI site, with the physical/chemical treatment plant (including solidification) and engineered landfill at the LF site.
 - PI-1N/LF-2N (Milton/Mississauga)
 - PI-13N/LF-2N (Milton/Mississauga)
 - PI-1N/LF-4N (Milton)
 - PI-13N/LF-4N (Milton)
 - PI-27E/LF-1E (Niagara Falls)
- The preliminary Phase 4 activities required for the detailed comparative evaluation of siting options.

1.3 SCOPE OF WORK

Design development for the proposed Facility is an ongoing process which is proceeding in parallel with and beyond the activities to evaluate alternative facility siting options and to select a preferred site(s) as part of Phase 4A of OWMC's Facilities Development Process. Engineering data, developed for the purposes of site selection, are therefore preliminary. Greatest attention was given to those facility characteristics which are most important in the comparative evaluation of siting options, so as not to understate the risks to human health, environmental impacts, or costs.

The Phase 4A site selection process was based on the Facility operating at its maximum potential capacity of 300 000 t/a by the year 2000, and assuming that all of the liquid effluent from the treatment process is solidified and disposed of in an engineered landfill. This mode of operation is referred to as "Total Solidification" in this report.

During Phase 4A, OWMC identified that they are considering a number of options for the disposal of treated effluent (Ref: OWMC²³) and the Phase 4A site selection process included an overview analysis to examine these alternative effluent disposal options (Ref: MMD¹⁶). The analysis had the prime objective of determining whether the selection of any of the alternative effluent disposal options under consideration would be constrained by the selection of any siting option.

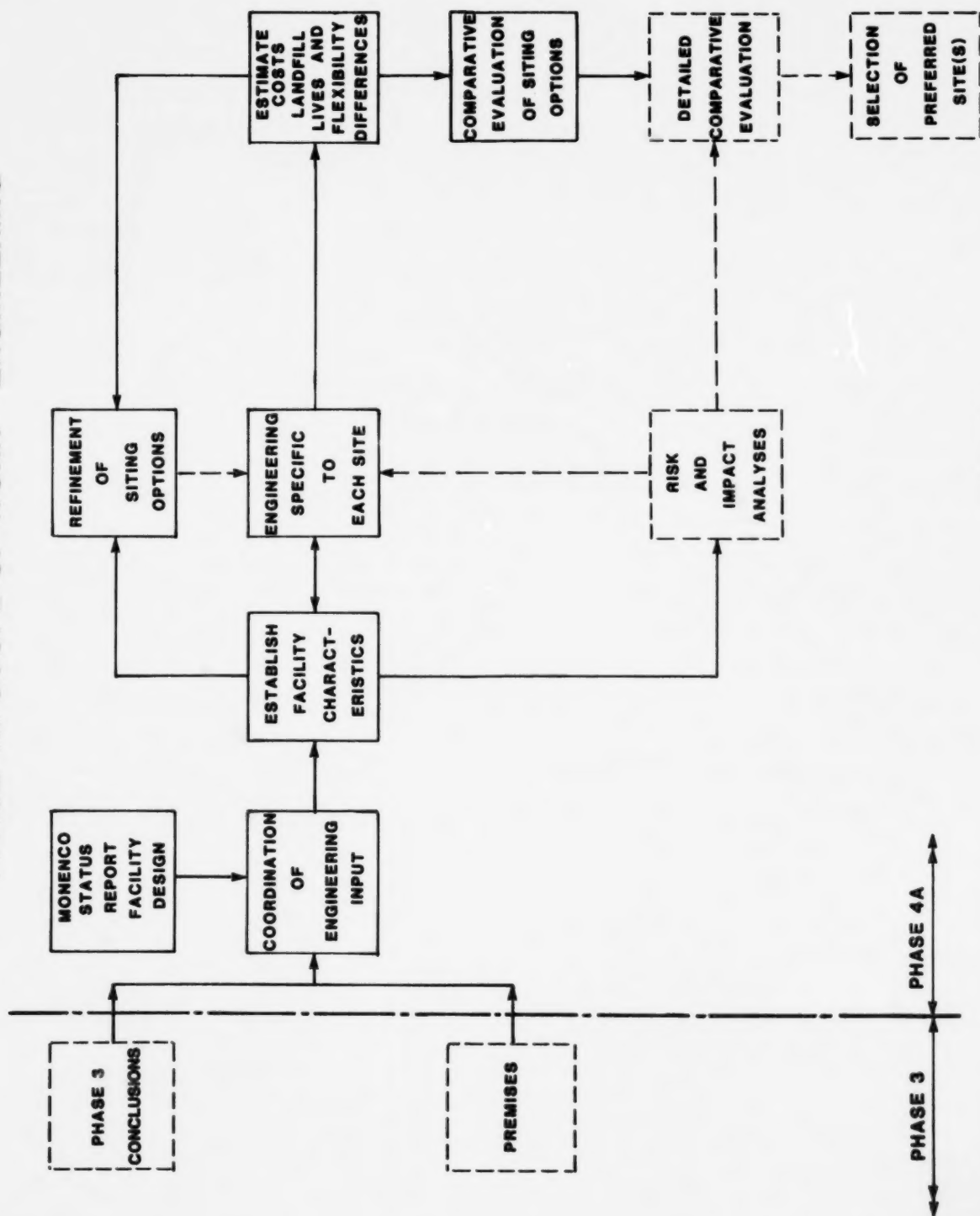
The analysis determined that none of the siting options under consideration would constrain the selection of any of the effluent disposal options (Ref: MMD¹⁶).

Given this situation, OWMC directed that "Partial Solidification with Evaporation", where treated effluent is evaporated and discharged to atmosphere while residues are solidified prior to disposal in the engineered landfill, was to be considered by each member of the site selection team in a sensitivity analysis (Ref: MMD¹⁶). The analysis was to determine whether the selection of this alternative, rather than total solidification, would affect the ranking of siting options resulting from the comparative evaluation.

The flowchart in Figure 1.3 shows the relationship between Phase 3 of the Facilities Development Process and the engineering scope of work necessary to satisfy the input to the selection of a preferred site(s) in Phase 4A.

Major items of engineering scope identified in Figure 1.3 are described in the following paragraphs.

FIGURE 1.3
PHASE 4A SCOPE OF WORK - ENGINEERING



1.3.1 COORDINATION OF ENGINEERING INPUT

Coordination of engineering input involved:

- Confirming with OWMC the premises established for use in Phase 4A.
- Documenting the preliminary engineering of OWMC's proposed Facility necessary to establish the facility characteristics information suitable for Phase 4A.
- Coordinating with the site selection team, modifications to the engineering design as a result of basic acceptability analyses, risk and impact analyses, and site specific variable and constraining features.
- Coordinating the engineering input to the detailed comparative evaluation of siting options.

1.3.2 ESTABLISH FACILITY CHARACTERISTICS

Characteristics of OWMC's proposed Facility, based on total solidification, were established and provided to other members of the site selection team for use in their risk and impact analyses.

An additional set of facility characteristics information was then produced for a Facility incorporating the alternative effluent disposal option, partial solidification with evaporation (Ref: MMD16), and this was provided to other members of the site selection team to form the basis of their sensitivity analysis on the alternative effluent disposal option.

Additional information was provided to the refinement of siting options analysis.

1.3.3 REFINEMENT OF SITING OPTIONS

Refinement of siting options consisted of the engineering input to the analyses as follows:

- Refinement of site boundaries for candidate sites LF-3C, LF-1E and PI-1N:
 - confirm that the Facility, including the technical buffer zone, could be accommodated within the site acquisition boundary (pp 53, 54).
- Assess Roads from the 400 series highways to each siting option:
 - confirm that the Facility layouts (Figures D.1, D.2, D.3, D.4 and D.5 in Appendix D) could be oriented on the sites such that the entrance to the Facility matched the alternative access road locations under consideration (p. 55).
- Rail Access to a candidate site:
 - confirm that the facility layouts (Figures D.1, D.2, D.3, D.4, and D.5 in Appendix D) could be oriented on the sites to accommodate the alternative rail access locations under consideration as well as the preferred access road (pp 55, 56), and
 - rank the rail access options based on a qualitative assessment of the relative differences.
- Location of physical/chemical treatment plant for partially integrated siting options:
 - input the estimated capital cost, operating cost and landfill life to compare the differences between a Case 2 versus a Cases 3 siting option, for each of the partially integrated siting options and then rank them (pp 56 to 60, 67).

1.3.4 ENGINEERING SPECIFIC TO EACH SITE

Engineering specific to each site consisted of the modifications to the engineering design and/or cost, specific to each site, which were developed for, or as an outcome of:

- Basic acceptability analyses conducted by each member of the site selection team to determine whether the more detailed information available in Phase 4A had revealed any severe constraints which might preclude further consideration of a particular site (pp 69, 70).

- Variable and constraining features, identified by members of the site selection team as part of their specific analyses (pp 70 to 86).
- Availability of utility services such as water, electric power, telephone and natural gas (pp 76, 77).

1.3.5 ESTIMATE COSTS LANDFILL LIVES AND FLEXIBILITY DIFFERENCES

Capital and operating costs of OWMC's proposed Facility were estimated for each siting option (pp 87 to 103) taking into account the engineering specific to each site addressed in Section 1.3.4.

Achievable landfill lives were estimated for each siting option (p. 111) taking into account the engineering specific to each site addressed in Section 1.3.4.

Flexibility differences between siting options, in terms of facility design options and facility layout constraints, were estimated for use in a sensitivity analysis (pp 126 to 135) as part of the comparative evaluation of siting options.

1.3.6 COMPARATIVE EVALUATION OF SITING OPTIONS

Monenco's role in the comparative evaluation of siting options involved the following:

- Comparing the landfill life that can be achieved at each siting option (p. 111).
- Performing an economic analysis of the capital and operating costs for the life of the Facility and ranking the siting options on the basis of cost (p. 117).
- Testing some of the assumptions established for Phase 4A by means of a sensitivity analysis to determine their effect on the ranking of siting options (pp 118 to 135).

- Documenting the above activities and summarizing the information for input into the detailed comparative evaluation as documented in the report "Site Selection Process. Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD¹⁶).

In May 1985, OWMC rejected site LF-2N because it could not be relied upon to provide natural containment (Ref: MMD¹⁸). It has, therefore, not been included in the comparative evaluation documented in this report. This rejection, resulting from the basic acceptability analysis (pp 69, 70), resulted in the number of siting options for comparative evaluation being reduced to nine.

1.4 APPROACH

The Site Selection Process, Phase 4A: Selection of Preferred Site(s), was conducted by a multi-discipline team of consultants, in which Monenco Limited, as a member and as OWMC's prime engineering consultant, provided engineering input.

As previously illustrated in Figure 1.1, the Phase 4A site selection process was a staged process which involved four major steps, as formulated by the site selection coordinating consultant, M.M. Dillon Limited (Ref: MMD¹⁶) in consultation with the site selection team.

1.4.1 STEP 1 - FACTOR IDENTIFICATION, DATA COLLECTION AND ANALYSIS

1.4.1.1 Factor Identification

As part of the approach to completing the comparative evaluation and ranking of siting options in terms of cost, "factors and indicators", as described in "Background Material for the OWMC Phase 4A Site Selection Workshops,

Volumes 1 & 2" (Ref: OWMC²²) and "Site Selection Process. Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD¹⁶) were identified and used.

A factor is defined as a positive or negative consideration which would assist in comparing siting options, in terms of risk, impacts or engineering considerations.

An indicator is an element or a subdivision of a factor and is defined as a more precise way of identifying, describing and predicting risks, impacts and engineering concerns.

The engineering factors and indicators used by Monenco and defined on the Factor Sheets in Appendix A were:

FACTOR GROUPING	FACTOR	INDICATORS
Engineering	Site Area	Site Size Landfill Life
	Capital Cost	Incineration Physical/Chemical Treatment Solidification On-Site Facilities Engineered Landfill On-Site Facilities (Site Specific) Off-Site Facilities
	Operating Cost	Fixed Operating Costs - general administration - taxes (municipal & business) - insurance - maintenance

FACTOR GROUPING	FACTOR	INDICATORS
	Operating Cost (Cont'd)	Variable Operating Costs - operating labour - utilities - additives and reagents - engineered landfill - transportation Start-up Decommissioning Post Closure and Long Term Care
	Flexibility	Facility Design - landfill design - effluent disposal option Facility Layout - conceptual arrangement - rail access - location of incinerator stack - expansion of technical buffer zone - expansion of landfill area

The indicator "Site Size" was used in the refinement of site boundaries (pp 53, 54) and as part of the basic acceptability analysis discussed in Chapter 4 (p. 70), to determine that the site area was large enough to accommodate the 300 000 t/a capacity Facility and/or separate landfill, including a technical buffer zone of 400 metres from sources of significant potential fugitive emissions within the central operating area (as defined in Section 2.2.3.5 p. 33) and a 50 metre buffer zone around the engineered landfill (Ref: MMD¹⁵).

Layouts of the central operating area including technical buffer zone for the Case 1, Case 2 and Case 3 siting combinations were prepared to a scale of 1:10 000. These layouts (see Figures 2.1, 2.2, 2.3, 2.4 and 2.5 pp 41 to 45), were then superimposed onto the 1:10 000 scale maps of each candidate site in accordance with the specific siting options and the preferred access roads, to verify that the various siting options could accommodate the required Facilities.

The indicator "Landfill Life" was used in the comparative evaluation of siting options discussed in Chapter 6 (pp 105 to 111), to determine that the available landfill area for each siting option was sufficient to meet OWMC's requirement for a minimum of 20 years operation and to compare landfill lives between siting options.

The landfill life was estimated at each landfill site taking into account:

- constraints imposed by the potential for flooding (Ref: GLAL⁸),
- hydrogeologic and geotechnical considerations (Ref: GLAL⁷), and
- assumptions on the annual volumes of solidified material to be disposed of and design features of the engineered landfill.

The results of the landfill life assessments were also used in the rail access analysis (pp 55, 56) and in the analysis for the location of the physical/chemical treatment plant for partially integrated siting options (pp 56 to 60, 67).

The capital and operating cost factors were subdivided into cost components (referred to as "Indicators", which are defined in the Factor Sheets given in Appendix A) to achieve a better understanding of how costs varied between the siting options and which costs were common to all siting options.

Only about 11% of the total estimated costs varied between siting options (see Figure 5.1 pp 96) and therefore effort was directed to ensure

that any feature specific to a site, which could effect design and cost, was considered at a level of detail sufficient for comparative evaluation. This is documented in Chapters 4, 5 and 6.

The capital and operating costs were used in the economic analysis described in Chapter 6 (pp 110 to 117), in order to rank the siting options on the basis of cost.

Cost information was also used in the rail access analysis (pp 55, 56) and in the analysis for the location of the physical/chemical treatment plant for partially integrated siting options (pp 55 to 60, 67).

Engineering flexibility was introduced as part of the sensitivity analysis (pp 118 to 135), performed after the comparative evaluation, to determine if the design development of the Facility (which is proceeding in parallel with Phase 4A site selection) would be significantly constrained by the selection of any siting option.

Although the constraints identified by other members of the site selection team, as discussed in Chapter 4 (pp 70 to 86), have been incorporated into the engineering specific to each site and hence reflected in the cost estimates presented in Chapter 5, there may be other constraining features which could significantly impact on the various options being considered by OWMC at the present time and the freedom for the engineer (Monenco Limited) to produce the optimal design. This factor was introduced to address this matter.

The engineering flexibility factor is essentially concerned with two aspects of the design development:

- facility design, and
- facility layout

which are further divided into sub indicators as discussed in Chapter 6 (pp 126 to 135).

1.4.1.2 Data Collection and Analysis

The Phase 4A site selection process proceeded in parallel with the development of preliminary designs for OWMC's proposed Treatment Facility. This design work is for a Facility having an initial capacity of 150 000 t/a and with provision for future expansion to an ultimate capacity of 300 000 t/a. The "Status Report - Facility Design" (Ref: MONENCO¹⁹) describes the proposed Facility at a level of conceptual engineering that can be achieved prior to the selection of a specific site. It includes a description of the process technologies and explains how the system will operate.

The facility characteristics information provided to the other members of the site selection team (pp 24 to 51) was established on the basis of the preliminary engineering for the 150 000 t/a Facility described in "Status Report - Facility Design" (Ref: MONENCO¹⁹), but expanded to 300 000 t/a capacity and adapted to take account of site specific conditions discussed in Chapter 4 (pp 68 to 86).

So that the Phase 4A site selection process would not understate the risks to human health, environmental impacts or costs, the facility characteristics information was established using a "worst case". The "worst case" was developed from a number of operating scenarios which represented extreme conditions that could be associated with OWMC's Treatment Facility e.g. gas emissions, quantity of water required on site, and volume of material to be disposed of in the engineered landfill, as described in Chapter 2 (p. 25).

As discussed in "Status Report - Facility Design" (Ref: MONENCO¹⁹) OWMC's Treatment Facility will require services to be brought to the site such as electric power, water, sanitary and storm sewers, and natural gas. The availability of services at each of the candidate sites was determined in discussions with the relevant local utility/municipality. Where services were not available at a particular site, alternatives were established; for

example, fuel oil in lieu of natural gas and raw water from a local river in lieu of municipal supply, as described in Chapter 4 (pp 76, 77).

The flow chart Figure 1.4 shows the interface between Monenco and other members of the site selection team and identifies constraint and cost input to Monenco's analysis, based on the facility characteristics information provided and the analyses undertaken by some of the site selection team as described in Chapter 4 (pp 68 to 86). Certain constraints, (Ref: GLAL⁷), required modifications to the engineering design as part of the basic acceptability analysis (pp 69, 70), to determine whether the more detailed information available in Phase 4A had revealed any severe constraints which might preclude further consideration of a particular site.

The final aspect of the data collection and analysis was to estimate capital and operating costs associated with locating the proposed Facility at each of the siting options. Costs were estimated in line with the "Factors" identified in Section 1.4.1.1 using the preliminary engineering identified in Section 1.4.1.2 as a basis, plus cost inputs provided by other members of the site selection team, as detailed in Chapter 5 (pp 93, 94 and 100).

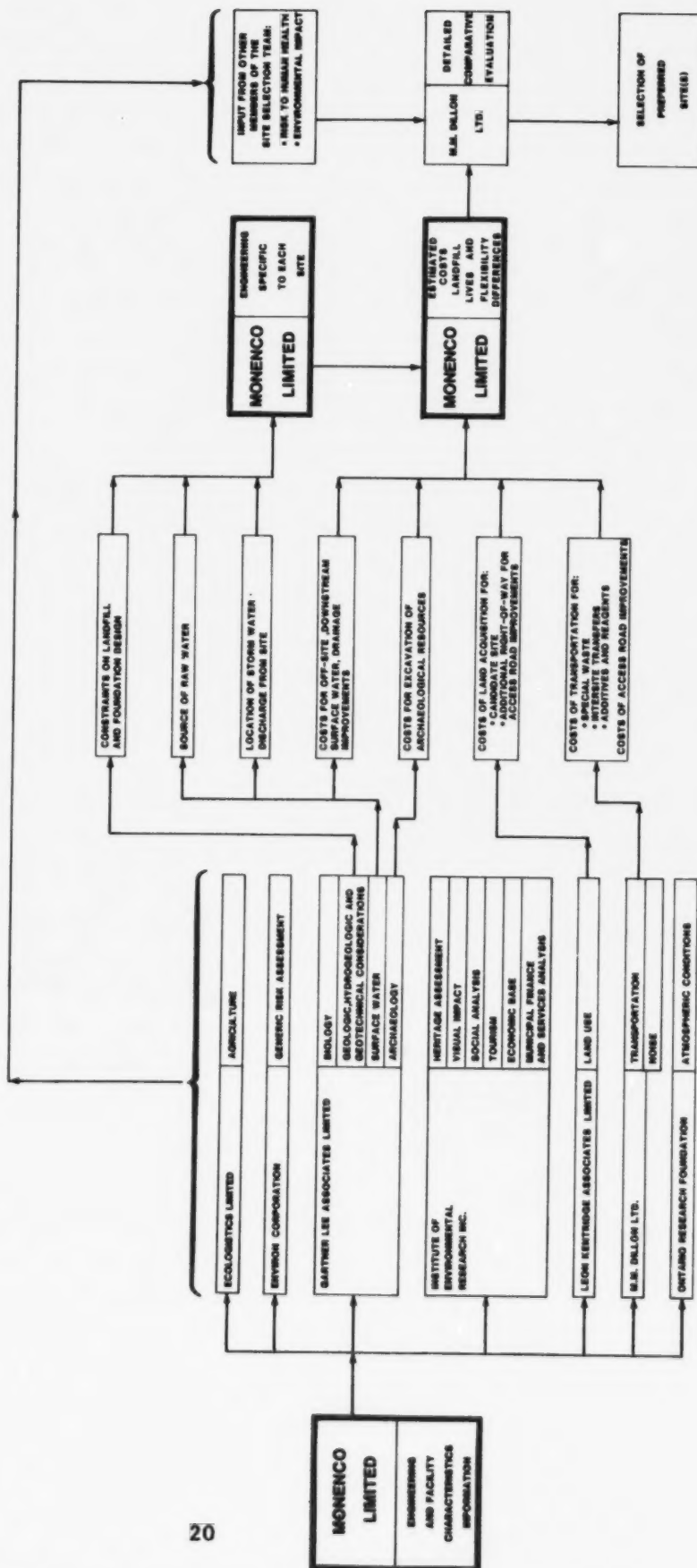
1.4.2 STEP 2 - REFINEMENT OF SITING OPTIONS

Refinement of siting options involved the examination of:

- refinement to site boundaries at sites LF-3C, LF-1E and PI-1N,
- access road options,
- rail access options, and
- options for locating the physical/chemical treatment plant.

Refinement of site boundaries was achieved by means of constraint mapping developed by the site selection team. Monenco's input was to confirm that the revised site boundaries would still accommodate the Facility and its technical buffer zone in accordance with:

FIGURE 1.4
MONENCO LIMITED INTERFACE WITH SITE SELECTION TEAM



- factor - Site Area, and
- indicator - Site Size
 - Landfill Life

as discussed in Chapter 3 (pp 53, 54).

Road and rail access options were selected and analysed by the site selection team. Monenco's input was to confirm that the facility layouts, established as part of the facility characteristics information, could be oriented on the candidate sites to accommodate the alternative road and rail access options being considered (pp 55, 56).

In addition, a qualitative assessment of the relative differences between the various rail access options at each candidate site was analyzed in order to rank the various options (pp 56, 61 to 66).

Options for locating the physical/chemical treatment plant either with the incineration plant at the PI site or with the landfill at the LF site were analysed by the site selection team. Monenco's input considered the capital and operating costs and the effect on landfill life (pp 56 to 60, 67).

1.4.3 STEP 3 - COMPARISON OF SITING OPTIONS

The comparison of siting options from an engineering perspective considered the estimated landfill life that could be achieved and the overall facility costs.

The landfill life was estimated taking into account the constraints identified by other members of the site selection team as discussed in Chapter 4 (pp 70 to 86), and the assumptions such as landfill cell profile and layout as discussed in Chapter 6 (pp 105 to 111).

Overall facility costs, expressed as present value of lifecycle annual costs (p. 117), were derived by means of an economic analysis using the

capital and operating costs over a twenty year life for the Facility, as established by the cost factors and indicators described in Chapters 5 and 6.

The comparative evaluation of siting options was further reviewed by means of a sensitivity analysis (pp 118 to 135) to determine if engineering flexibility differences or various options currently being considered by OWMC and/or assumptions postulated by Monenco would have an effect on our ranking of siting options and hence the selection of a preferred site(s). In addition we were required to analyse (Ref: MMD¹⁶) the effect of:

- transporting additives and reagents (required by the treatment processes) by rail versus truck,
- changes to the site size at candidate sites LF-3C and LF-1E, and
- use of partial solidification with evaporation for the disposal of treated effluent.

1.4.4 STEP 4 - CONCLUSIONS AND RECOMMENDATIONS

The fourth and final step involved ranking of siting options based on the economic analysis and presenting conclusions resulting from the economic analysis, estimates of landfill life and the relative flexibility differences at each site. This step concluded with the preparation of recommendations from an engineering perspective (pp 156, 157).

1.5 REPORT FORMAT

This introductory chapter, Chapter 1, explains how this engineering report forms a part of OWMC's five phase Facilities Development Process and in particular Phase 4A, the selection of a preferred site(s). This chapter also discusses the scope of work identified for Phase 4A and the approach taken to accomplish this scope of work.

Chapter 2 explains the basis for establishing the facility characteristics information and presents this information in summary form.

Chapter 3 documents the engineering input to the refinement of siting options which finalized or selected:

- site acquisition boundaries,
- preferred access roads,
- preferred rail access, and
- location of the physical/chemical treatment plant.

Chapter 4 summarizes the engineering specific to each site which was developed for, or as an outcome of, the basic acceptability analysis. In addition, variable and constraining features at each candidate site are addressed. This data was used in estimating the site specific costs of OWMC's Treatment Facility.

Chapter 5 presents the capital and operating costs which were estimated for each siting option.

Chapter 6 provides a discussion on landfill life and the assumptions used in Phase 4A and documents the economic analysis which was performed, as part of the comparative evaluation of siting options, using the capital and operating costs detailed in Chapter 5. This chapter also discusses the sensitivity analysis that was conducted as part of the comparative evaluation.

Chapter 7 examines the use of partial solidification with evaporation as the alternate effluent disposal option selected for Phase 4A (Ref: MMD16).

Chapter 8 presents Monenco's conclusions and recommendations from an engineering perspective, including the effects of using partial solidification with evaporation for disposing of treated effluent.

CHAPTER 2

FACILITY CHARACTERISTICS INFORMATION

2.1 INTRODUCTION

The "Status Report - Facility Design" (Ref: MONENCO¹⁹) describes the type of Facility envisaged during the period when engineering data was being prepared to form a basis for Phase 4A site selection. That report represents the level of conceptual engineering that can be achieved prior to selection of a specific site(s), and includes information on process technologies employed, the physical arrangement of the Facilities and the proposed method of operation.

Readers of this report are encouraged to familiarize themselves with the earlier "Status Report - Facility Design" (Ref: MONENCO¹⁹), since the descriptive material contained in that report has been purposely omitted here, for brevity. However, where there are inconsistencies between the two reports, the contents of this report apply for the purposes of Phase 4A site selection. This may occur in a number of places, since site selection is based on a "worst case" established from extreme assumptions, as further explained below.

While the design is based on an initial facility capacity of 150 000 t/a of special waste comprising 120 000 t/a of inorganic waste and 30 000 t/a of organic waste, provision has been included for expansion of the Facility to an ultimate capacity of 300 000 t/a, should this prove necessary in the future.

The analyses performed by the site selection team required a complete description of the proposed Facility, with particular emphasis on areas where differences occur between the various siting options.

OWMC directed that Phase 4A of the site selection process, the comparative evaluation of the siting options to select a preferred site(s), be based on a 300 000 t/a Facility operating at full capacity by the year 2000. Monenco provided details of such a Facility by preparing documentation during Phase 4A entitled "Facility Characteristics Information". This information was based on the preliminary engineering of the 150 000 t/a Facility described in the "Status Report - Facility Design" (Ref: MONENCO¹⁹), but expanded to 300 000 t/a capacity and adapted to take account of site specific conditions.

Furthermore, to ensure that the Phase 4A site selection process would not underestimate risks to human health, environmental impacts and costs, a "worst case" was established from a number of operating scenarios representing extreme operating conditions which could be associated with OWMC's Treatment Facility. A number of basic assumptions were used in establishing the "worst case" or extreme operating conditions, including the following:

- Conservatively low assumptions on the likely solids content of inorganic waste delivered to the Facility, resulting in maximum quantities of treated effluent requiring disposal.
- Minimum re-use of treated effluent in the Facility, thus increasing the likely quantities of effluent requiring disposal.
- Maximum quantity of leachate generated in the landfill.
- The leachate will require treatment, thus increasing the quantities of effluent requiring disposal.
- The above assumptions also maximize the estimates of additives and reagents required and the volume of solidified material to be landfilled, thereby resulting in conservatively low estimates of landfill life and high estimates of transportation quantities.
- Conservatively high estimates of incinerator stack emissions, plant fugitive emissions, spills and leaks occurring on the Facility, and other process upsets or on-site accidents.

The facility characteristics information supplied to the site selection team for evaluation of the siting options has been summarized and is presented in a tabular, abbreviated, point form in this chapter. Information is provided on facility design features, as well as its construction and operation, under the following headings:

- Construction of the Facility:
 - Initial Facility (150 000 t/a Capacity), and
 - Expanded Facility (300 000 t/a Capacity).

- Operation of the Facility:
 - Emissions and effluents,
 - Engineered containment,
 - Transportation requirements,
 - Anticipated noise levels,
 - Candidate sites, technical buffer zones and layouts,
 - Visual appearance and lighting,
 - Dust,
 - Hours of operation,
 - Employment levels,
 - Services for the Facility, and
 - Taxation and zoning.

2.2 FACILITY CHARACTERISTICS INFORMATION			REFERENCE
2.2.1 SITING OPTIONS			OWMC ²¹ MMD ¹⁶
The siting options have been established by combining the process technologies on one or more of the candidate sites as follows:			
Case 1 - Integrated	LF-9C	(West Lincoln)	
(All processes on one site)	LF-3C	(West Lincoln)	
	LF-1E	(Niagara Falls)	
Case 2 - Landfill Separate	LF-4N/PI-1N	(Milton)	
(Landfill on LF site, Phys/Chem Treatment and Incineration plant on PI site)	LF-4N/PI-13N	(Milton)	
	LF-1E/PI-27E	(Niagara Falls)	
Case 3 - Incinerator Separate	PI-1N/LF-4N	(Milton)	
(Incineration plant on PI site, Phys/Chem Treatment and Landfill on LF site)	PI-13N/LF-4N	(Milton)	
	PI-27E/LF-1E	(Niagara Falls)	
2.2.2 CONSTRUCTION OF THE FACILITY			
The construction of OWMC's Treatment Facility will take place in two separate stages:			
2.2.2.1 Initial Facility (150 000 t/a Capacity)			
● 18 month schedule (see Figure 6.1 p. 113)			

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
• Normal working week (8 hours/day, 5 days/week) with no overtime envisaged. • Average construction labour force of 360 with a peak of 600 occurring during month 10 to month 16. • Principal trades will be pipe fitters, welders, electricians, ironworkers, carpenters and labourers, although most other trades will be represented. • All candidate sites are within commuting distance of a large pool of construction labour. • No construction camps required. • Construction labour will travel to site in car pools and/or special buses. • Services, local trade subcontractors, machine shops, hardware, catering and fuel supplies will be obtained locally, where practical. • All construction work will be carried out to the standards of the Construction Safety Association of Ontario. This will include a construction site safety program, safety inspectors and supervisors, suitable ambulance and first aid service on site and co-operation with the local medical services. • Construction dust will be generated from the brief earth moving operation during the first few months, from vehicular movement on the construction site and from the development of the landfill site including construction of the initial cell. The permanent site road beds will be installed at the start of the initial facility work and will be kept clean in order to keep dust to a minimum. • The initial work at site will also include the installation of fencing and drainage, with earth moving activities carried out only where absolutely necessary. This will minimize erosion of the site and carry over of clay/mud to the neighbouring roads.	

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
● Noise from the site will be typical for construction of most process type plants of this size, with ten ton trucks entering and leaving the site every ten minutes during the working day over the eighteen month period. The peak noise would probably be during the earth moving phase, equivalent to six 20 ton dump trucks or six D9 bulldozers and six Euclid scrapers on site eight hours per day over a duration of 6 to 8 weeks. During the mechanical erection phase of the project, approximately 12 months, the noise will probably be equivalent to six 1000 CFM air compressors plus twenty 300 amp welding machines (gas driven) running continuously during the working day. There will also be a background of general site noise accompanying pipe fabrication and erection of steel work. <u>2.2.2.2 Expanded Facility (300 000 t/a Capacity)</u> ● 18 month schedule with completion at the end of the fifth year of operation (see Figure 6.1 p. 113). ● Average construction labour force of 130 with a peak of 210 occurring during month 10 to month 16. ● No earthmoving phase will be required. ● All other characteristics are as per the initial Facility. <u>2.2.3 OPERATION OF THE FACILITY</u> The characteristics associated with operation of the Facility, for the Phase 4A site selection process, are based on a 300 000 t/a Facility operating in the year 2000 A.D. with exceptions noted to account for the build up and expansion during the first ten years of operation. These characteristics are described in this section.	

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
<u>2.2.3.1 Emissions and Effluents</u> Emissions and effluents are defined as gaseous and liquid discharges respectively, which are released from the Facility and include: • emissions from the incineration plant stack, • fugitive atmospheric emissions, • sanitary sewage effluent, and • uncontaminated surface drainage. <u>Stack and Fugitive Atmospheric Emissions</u> Minimizing risk to human health is the most highly ranked goal of OWMC in guiding the Facilities Development Process. A generic risk assessment was undertaken as part of Phase 4A in order to provide a better understanding of the relative importance of siting factors related to human health risk (Ref: ENVIRON⁵). The generic risk assessment was designed to provide quantitative estimates of public health risk associated with the emission of contaminants from the proposed Facility. The engineering input to risk assessment identified the gaseous emissions associated with normal facility operation, upset conditions and potential on-site accidents and is documented in a report "Preliminary Estimate of Gas Emissions for Risk Assessment", summarized in Appendix B.1. <u>Sanitary Sewage Effluent</u> Sanitary sewage from the site will be treated on-site and the treated effluent will be discharged with the uncontaminated surface drainage (p. 31).	

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
<u>Uncontaminated Surface Drainage</u> Uncontaminated surface drainage (clean storm water) will be controlled and discharged off-site to a suitable local watercourse as shown on Tables 2.4, 2.5 and 2.6 (pp 49 to 51) and "Service Connections" Figures in Appendix D. <u>2.2.3.2 Engineered Containment</u> Particular attention is given to spill and leak prevention in the engineering design of the Facility. Equipment will be specified, purchased and maintained in order to ensure its integrity and reliability. Several levels of process operating safeguards will also be in effect. However, in the event that all levels of this process operating protection fail, the management of leaks and spills will be achieved by means of a comprehensive plan of isolation, collection and clean-up. A series of potential events which could result in spills or leaks in the central operating area is provided in "Engineered Containment" in Appendix B.2. This was the engineering input to Gartner Lee Associates Limited hydrogeologic assessment and basic acceptability analysis (Ref: GLAL⁷).	GLAL⁸

2.2 FACILITY CHARACTERISTICS INFORMATION					REFERENCE
2.2.3.3 Transportation Requirements					OWMC
Quantity of Special Waste					
The quantity of special waste to be treated at OWMC's Treatment Facility will increase to 300 000 t/a by year 10 as follows:					
Quantity of Special Waste (t/a)					
● Year of Operation	Total	Organic	Inorganic		
1	50 000	20 000	30 000		
2	70 000	20 000	50 000		
3	105 000	25 000	80 000		
4	130 000	30 000	100 000		
5	150 000	30 000	120 000		
6	180 000	36 000	144 000		
7	210 000	42 000	168 000		
8	240 000	48 000	192 000		
9	270 000	54 000	216 000		
10	300 000	60 000	240 000		
Characteristics of the Special Wastes					OWMC
The characteristics of the 300 000 t/a of special wastes are described in Table C.1 in Appendix C.					
Transportation of Special Wastes, Additives and Reagents and Intersite Transfers					
The quantities of special waste and intersite transfers are shown on Table 2.1 (p. 46). The quantities of additives and reagents and assumed location of suppliers are shown on Table 2.2 (p. 47).					

2.2 FACILITY CHARACTERISTICS INFORMATION			REFERENCE
2.2.3.4 Anticipated Noise Levels			
The anticipated noise levels were estimated for the equipment associated with each area shown on the "Layout of Operating Area", Figures D.1 to D.5 in Appendix D and are summarized on Table C.2 of Appendix C. The anticipated noise levels associated with operation of the landfill are provided in Table C.2 of Appendix C.			
2.2.3.5 Candidate Sites, Technical Buffer Zones and Layouts			
<u>Candidate Sites</u>			
● The candidate sites are shown on "Site Layout" Figures in Appendix D. ● The site sizes are:			OWMC ²¹ MMD ¹⁶ OWMC ²¹
	Phase 3	Phase 4A	
- LF-9C	135 ha	135 ha	
- LF-3C	259 ha	206 ha	
- LF-1E	273 ha	273 ha(135 ha for partially integrated siting siting option)	
- LF-4N	168 ha	168 ha	
- PI-1N	378 ha	175 ha	
- PI-13N	170 ha	170 ha	
- PI-27E	188 ha	188 ha	
<u>Technical Buffer Zones</u>			
● The central operating area (physical/chemical treatment plant with solidification, incineration and on-site facilities) will be surrounded by a 400 m technical buffer zone measured from the physical/chemical treatment plant, the physical/chemical			MMD ¹⁵

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE														
tank storage, the incinerator tank farm, the tank truck unloading bays including the incinerator waste receiving tanks and the drum storage and handling building. • The engineered landfill will be surrounded by a 50 m buffer zone. • Figures 2.1, 2.2, 2.3 and 2.4 (pp 41 to 44) show the layouts for the central operating area together with the technical buffer zone for Case 1, Case 2 and Case 3 siting options. • Figure 2.5 (p. 45) shows a separate layout for candidate site LF-9C together with its technical buffer zone as discussed in Chapter 4 (p. 72). <u>Layout of Central Operating Area</u> • Central operating area layouts for Case 1, Case 2 and Case 3 siting options are shown on Figures D.1 to D.5 in Appendix D. The areas of the central operating area are: <table border="0"> <tr> <td>- Case 1 (Integrated siting option)</td><td>17.4ha</td></tr> <tr> <td>- Case 1 (Integrated siting option LF-9C)</td><td>19.9ha</td></tr> <tr> <td>- Case 2 (Landfill Separate siting option)</td><td></td></tr> <tr> <td> Phys/Chem and Incineration Plant</td><td>17.7ha</td></tr> <tr> <td>- Case 3 (Incinerator Separate siting option)</td><td></td></tr> <tr> <td> Incineration Plant</td><td>10.7ha</td></tr> <tr> <td> Physical/Chemical Treatment Plant</td><td>10.2 ha</td></tr> </table> • The site layouts for the siting options under consideration are shown on "Site Layout" Figures in Appendix D. • Building and pond sizes are summarized in Table 2.3 (p. 48).	- Case 1 (Integrated siting option)	17.4ha	- Case 1 (Integrated siting option LF-9C)	19.9ha	- Case 2 (Landfill Separate siting option)		Phys/Chem and Incineration Plant	17.7ha	- Case 3 (Incinerator Separate siting option)		Incineration Plant	10.7ha	Physical/Chemical Treatment Plant	10.2 ha	MMD¹⁵
- Case 1 (Integrated siting option)	17.4ha														
- Case 1 (Integrated siting option LF-9C)	19.9ha														
- Case 2 (Landfill Separate siting option)															
Phys/Chem and Incineration Plant	17.7ha														
- Case 3 (Incinerator Separate siting option)															
Incineration Plant	10.7ha														
Physical/Chemical Treatment Plant	10.2 ha														

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
2.2.3.6 Visual Appearance and Lighting <u>Visual Appearance</u> ● A perspective of a 300 000 t/a integrated Facility is shown on Figure D.6 in Appendix D. ● A perspective of a 300 000 t/a integrated Facility for siting option LF-9C is shown on Figure D.7 in Appendix D. ● The incinerator stack will be a minimum of 60 m and a maximum of 100 m high and will accommodate two flues of 1.3 m diameter. ● The Facility will be enclosed by a 2.5 m high chain link fence topped with three strands of barbed wire as follows: - Case 1 siting options will be fenced around the central operating area, around the site acquisition boundary and along the access road between the site acquisition boundary and the central operating area. - Case 2 siting options will be fenced around the site acquisition boundary for the landfill site and around the central operating area for the physical/chemical/incineration plant site. - Case 3 siting options will be fenced as Case 1 for the landfill/physical/chemical site and around the operating area only for the incineration plant site. ● Landfill cells will be "conventional" type cells and typically measure 100 m wide by 400 m long and have a profile as shown in Table 4.8 (p. 86). ● Landfill cells will be typically spaced 20 m apart and at least 50 m in from the site acquisition boundary. ● The space between landfill cells will be infilled with the excess earth from cell excavations. ● The landfill will have a 5 m high berm around the whole site, located just inside the fence.	OWMC GLAL⁷

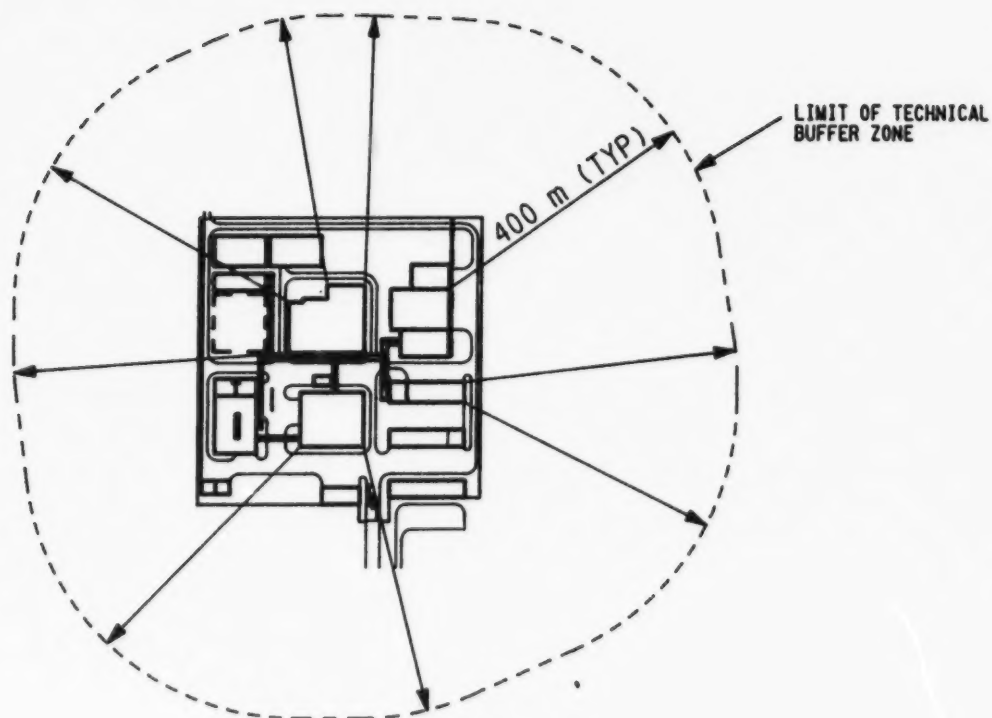
2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
<u>Lighting</u> • The central operating area and roadways will be lit all night with lighting focussed downwards and hence should not cast light outside of the technical buffer zone. • The incinerator stack will be lit in accordance with the requirements of Transport Canada, which requires two red dual unit flashing hazard beacons located 6 feet below the top of the stack and two dual unit red steady burning obstruction lights at the half way point. The lights must be visible from any angle around the stack. • Local mobile lighting units will be provided for safety during any night discharge of solidified material into the open landfill cell. <u>2.2.3.7 Dust</u> Several potential sources of dust from landfill sites are as follows: • Excavation and stockpiling of soils during cell construction: - Potential for dust generation is low because soils will have high moisture content. - Frequency - 2 months duration, twice per year. • Desiccation of stockpiled soil and wind generated dust: - This is a possibility and might be controlled through the use of soil stabilization agents or grassing of stockpiles. - Frequency - all the time. • Dust generation by vehicles during filling of landfill cells: - This is a possibility if some or all solidified material is trucked to landfill.	MMD¹⁷

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
- Source could be either road dust or dust from exposed surfaces of solidified mass that are subject to traffic. - Road dust will be minimized by the use of paved or good all weather granular road surfaces and light application of dust control chemicals or water applied to road surface if required during dry spells. - Regular road cleaning and maintenance will help minimize dust. - Dust generated from the solidified mass by wind or vehicular traffic will be controlled by minimizing the time of exposure of surfaces and possibly by light applications of water. - Frequency - all the time. ● Dust generated by handling and placement of clay and topsoil during placement of final cover over filled cells: - Although stockpiled materials are likely to have reasonably high moisture content there is some potential for dust generation but it would be short term. - There is also a potential for dust generation by wind until the vegetation cover is established on the topsoil. This can be minimized through the use of soil stabilizing agents. - Frequency - 1 month duration, twice per year.	
<u>2.2.3.8 Hours of Operation</u> <u>Incineration Plant</u> ● Operation will be 3 shifts/day, 24 hours/day, 7 days/week, 7000 hours/year.	

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
<u>Physical/Chemical Treatment Plant</u> ● Operation for 50 000 t/a will be a single shift/day, 5 days/week, 50 weeks/year. Increased capacity will be handled by additional shifts to the maximum of 3 shifts/day. <u>Solidification Plant</u> ● Operation will be a single shift/day, 5 days/week, 50 weeks/year. Increased capacity will be handled by additional shifts to the maximum of 3 shifts/day in accordance with the requirements of the physical/chemical treatment plant. <u>Engineered Landfill</u> ● Operation for Case 1 (integrated), Case 2 (landfill separate) and Case 3 (incinerator separate) siting options will vary as follows: - Case 1 and Case 3; transportation of material from the solidification plant to the landfill by pipeline or conveyor will initially be a single shift/day, 5 days/week, 50 weeks/year with increased capacity being handled by additional shifts to the maximum of 3 shifts/day in accordance with the requirements of the solidification plant. Landfilling operations using heavy equipment, such as bulldozers and compacters, will operate only during daylight hours. - Case 2; operation will be a single shift/day, 5 days/week, 50 weeks/year. <u>2.2.3.9 Employment Levels</u> ● The total employment levels for the 300 000 t/a Facility are: - Case 1 (integrated) 221 persons - Case 2 (landfill separate) 217 persons - Case 3 (incinerator separate) 231 persons	

2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
● A breakdown of employment by job description is given in Table C.3 in Appendix C. Note: The reduction in employment levels for a Case 2 (landfill separate) siting option compared to a Case 1 (integrated) siting option is due mainly to the separate landfill site only working 1 shift/day, whereas, at the integrated site, additional personnel will be required for 3 shifts/day to operate the pipeline and conveyor for placing the solidified material in the landfill cell. In respect of a Case 3 (incinerator separate) siting option, the difference in employment levels is due to the duplication of administration and services personnel associated with this partially integrated siting option. 2.2.3.10 <u>Services for the Facility</u> ● Services required for the operation of the Facility include: - surface water drainage discharge (clean storm water), - sanitary sewage - water from municipal system (potable water), - water from watercourses (raw water), - natural gas, - electric power, and - telephone. ● Services will use existing road allowances for routing, where possible, and will be buried, except for electric power which will use overhead pole lines. Sources of services are listed in Tables 2.4, 2.5 and 2.6 (pp 49 to 51) and are shown on "Service Connections" Figures in Appendix D.	GLAL⁸ GLAL⁸

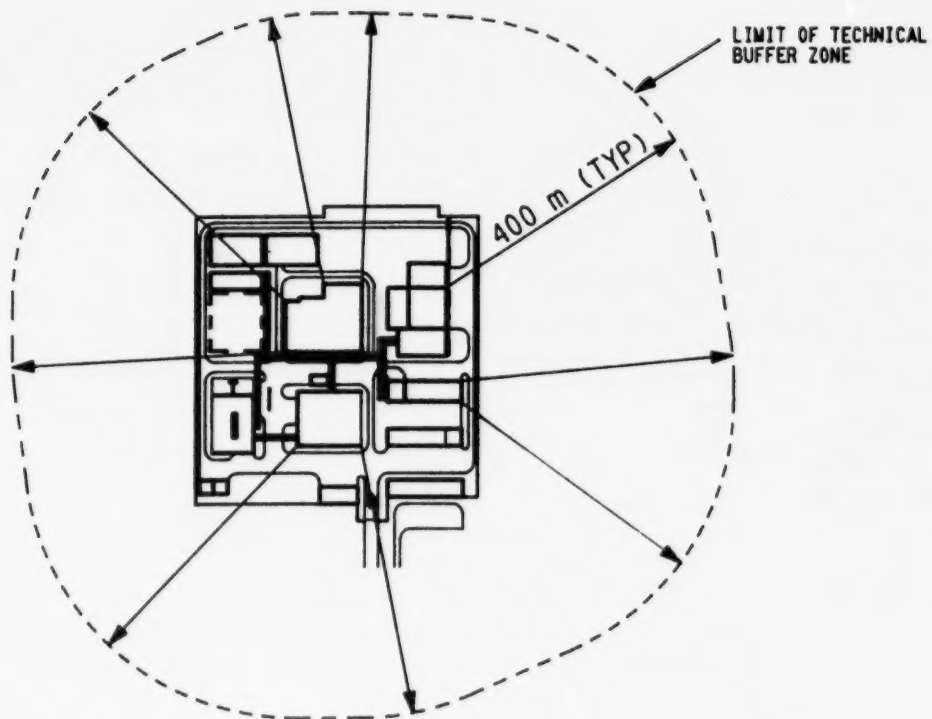
2.2 FACILITY CHARACTERISTICS INFORMATION	REFERENCE
2.2.3.11 Taxation and Zoning ● Details of the parts of the Facility which are subject to tax assessment are given in Table C.4 of Appendix C. ● The average annual labour charge is \$36,500 per employee including vacation and benefits. ● In respect of the economic base analysis (Ref: CLAYTON¹) the labour component of the fixed operating cost indicator shown on table E-4 in Appendix E is as follows: - General administration, taxes and insurance. \$1,788,500 - Maintenance. \$1,022,000 ● Areas of the candidate sites which can be zoned industrial by year 10 of operation are: - Case 1 (integrated siting option) 79.4ha - Case 1 (integrated siting option LF-9C) 81.9ha - Case 2 (landfill separate siting option) - Phys/Chem/Incineration Plant site 17.7ha - Separate Landfill site 62.0ha - Case 3 (incinerator separate siting option) - Incineration Plant site 10.7ha - Phys/Chem/Landfill site 72.2ha	CLAYTON¹ CLAYTON¹



0 100 200 300 METRES
 SCALE 1:10 000

NOTE:
 FOR DETAILS OF CENTRAL OPERATING
 AREA, REFER TO FIGURE D.1
 APPENDIX D.

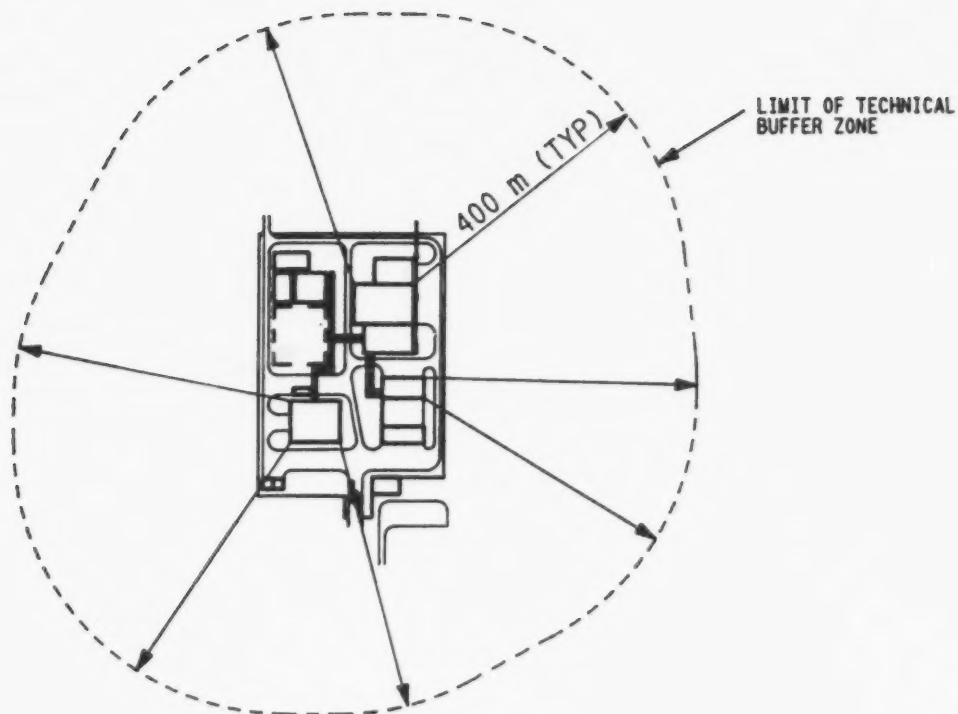
FIGURE 2.1
TECHNICAL BUFFER ZONE
CASE 1 - INTEGRATED
CENTRAL OPERATING AREA
300 000 t/a CAPACITY



0 100 200 300 METRES
 SCALE 1:10 000

NOTE:
 FOR DETAILS OF CENTRAL OPERATING
 AREA, REFER TO FIGURE D.2
 APPENDIX D.

FIGURE 2.2
TECHNICAL BUFFER ZONE
CASE 2 - LANDFILL SEPARATE
CENTRAL OPERATING AREA
300 000 t/a CAPACITY

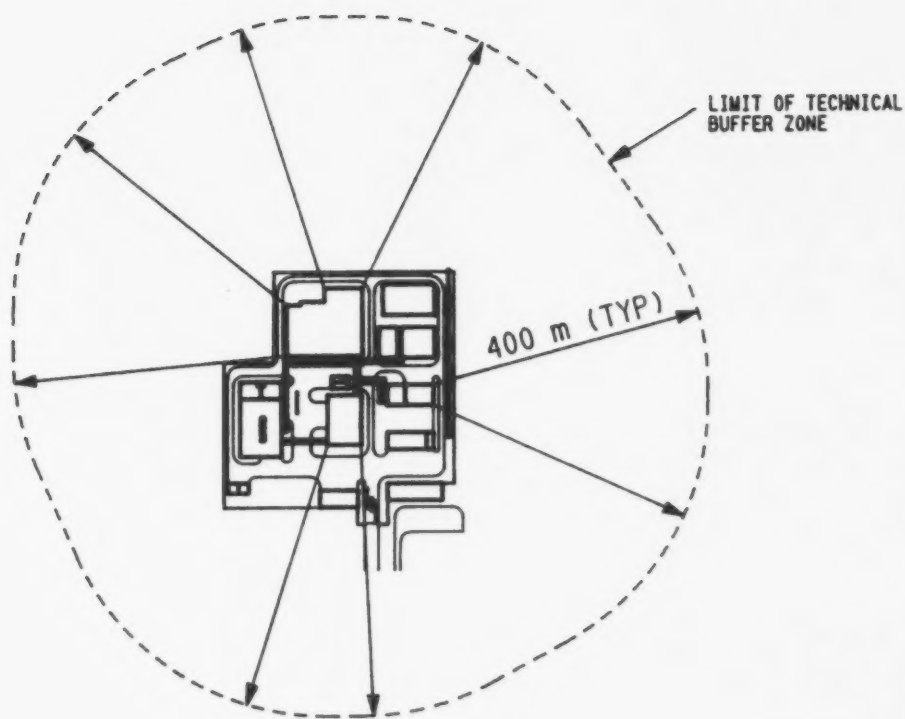


0 100 200 300 METRES

SCALE 1:10 000

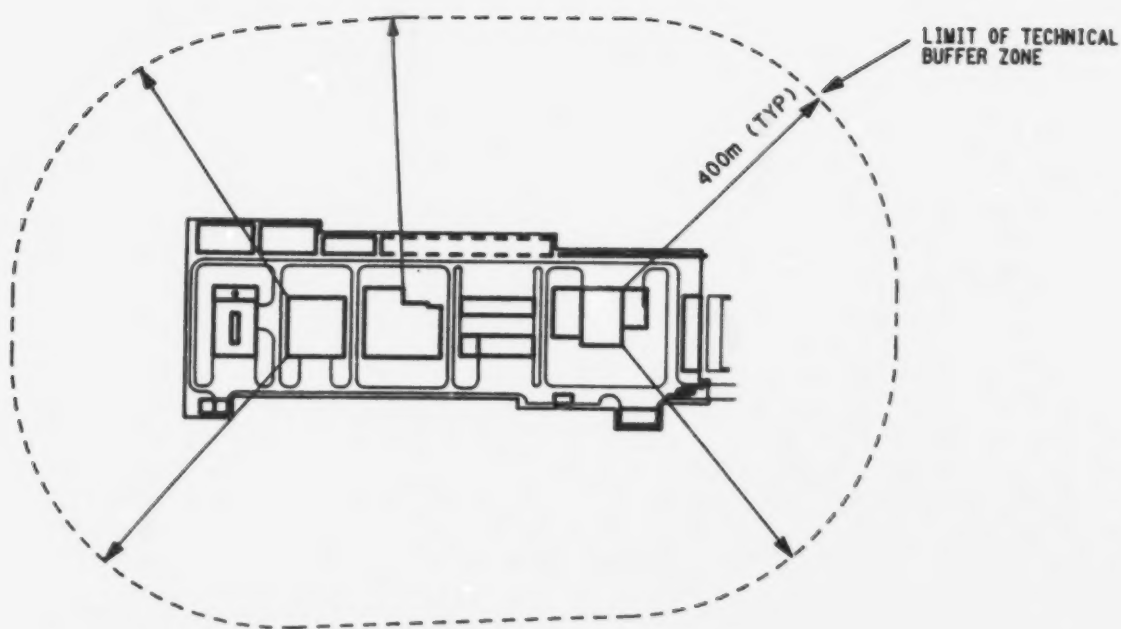
FIGURE 2.3
TECHNICAL BUFFER ZONE
CASE 3 - INCINERATOR SEPARATE
PHYSICAL/CHEMICAL TREATMENT OPERATING AREA
300 000 t/a CAPACITY

FOR DETAILS OF CENTRAL OPERATING
 AREA, REFER TO FIGURE D.3
 APPENDIX D.



NOTE:
FOR DETAILS OF CENTRAL OPERATING
AREA, REFER TO FIGURE D.4
APPENDIX D.

FIGURE 2.4
TECHNICAL BUFFER ZONE
CASE 3 - INCINERATOR SEPARATE
INCINERATION PLANT OPERATING AREA
300 000 t/a CAPACITY



0 100 200 300 METRES
 SCALE 1:10 000

FOR DETAILS OF CENTRAL OPERATING
 AREA, REFER TO FIGURE D.5
 APPENDIX D.

FIGURE 2.5
TECHNICAL BUFFER ZONE
CASE 1 - INTEGRATED LF-9C
CENTRAL OPERATING AREA
300 000 t/a CAPACITY

TABLE 2.1
TRANSPORTATION QUANTITIES OF SPECIAL WASTES AND INTERSITE TRANSFERS

DESCRIPTION	CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE	
	PHYS/CHEM INCINERATOR LANDFILL	PHYS/CHEM INCINERATOR	LANDFILL	PHYS/CHEM LANDFILL	INCINERATOR
	Tonnes per year	Tonnes per year	Tonnes per year	Tonnes per year	Tonnes per year
Pumpable waste	205 600	205 600	-	177 800	27 800
Non-pumpable waste	85 400	85 400		56 000	29 400
Drummed waste (Note 3)	9 000	9 000		7 200	1 800
TOTAL WASTE	300 000	300 000	-	241 000	59 000
Solidified material to landfill	-	384 300	-	-	-
Granular material for drainage system in landfill	30 000	-	30 000	30 000	-
Ash from incineration plant site to phys/chem site	-	-	-	-	13 000
Liquid blowdown from incineration plant to phys/chem site	-	-	-	-	4 800
Oil/water from phys/chem site to incineration plant site	-	-	-	1 000	-
Slag from incineration plant site to landfill	-	7 600	-	-	7 600
Contaminated storm runoff from incineration plant to phys/chem	-	-	-	-	7 200
Leachate from landfill to phys/chem	-	-	36 400	-	-
Truck wash water from incineration plant to phys/chem	-	-	-	-	4 800
Treated water to incineration plant	-	-	-	4 800	-

- NOTES:**
1. Based on Total Solidification
 2. Quantities are for year 10, 300 000 t/a waste delivered.
 3. 3% of total waste, delivered in 200 L (45 gal) drums.

TABLE 2.2

TRANSPORTATION QUANTITIES OF ADDITIVES
AND REAGENTS

TREATMENT PROCESS	ADDITIVE OR REAGENT	PHYSICAL STATE	QUANTITY DELIVERED PER YEAR	SOURCE SHIPPING LOCATION	COST \$ FOB SUPPLIER
PHYSICAL/CHEMICAL TREATMENT AND SOLIDIFICATION	Cement	Powder	52 700 t	Mississauga	5,533,000
	Sodium Silicate	Liquid	21 700 t	Etobicoke	3,841,000
	Sulphur Dioxide	Liquid	100 t	Cornwall	78,000
	Chlorine	Liquid	400 t	Cornwall	220,000
	Caustic Soda	50% Liquid	640 t	Cornwall	129,000
	Hydrated Lime	Solid	7 400 t	Toronto	542,000
	Activated Carbon	Solid	100 t	Hamilton	540,000
	Nitrogen	Liquid	8 000 Nm ³	Scarborough	5,000
INCINERATION	Caustic Soda	50% Liquid	5 600 t	Cornwall	1,126,000
	Calcium Oxide	Solid	2 380 t	Ingersoll	167,000
	Nitrogen	Liquid	16 000 Nm ³	Scarborough	10,000
	Miscellaneous	-	-	-	1,255,000
	Miscellaneous Consumables	-	-	-	181,000

- NOTES:
1. Based on Total Solidification
 2. Quantities are for year 10, 300 000 t/a waste delivered.
 3. Alternative chemicals, sodium bisulphite and sodium hypochlorite, are being considered to replace sulphur dioxide and chlorine respectively.

TABLE 2.3
BUILDING AND POND SIZES
CENTRAL OPERATING AREA - 300 000 t/a CAPACITY

LEGEND	CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE	CASE 3 - INCINERATOR SEPARATE	
			INCINERATION PLANT	PHYS/CHEM PLANT
PHYSICAL/CHEMICAL TREATMENT PLANT	57 x 82 x 24 H	57 x 82 x 24 H	—	57 x 82 x 24 H
INCINERATION PLANT	60 x 110	60 x 110	60 x 110	—
SOLIDIFICATION PLANT	35 x 57 x 22 H	35 x 57 x 22 H	—	35 x 57 x 22 H
PHYSICAL/CHEMICAL TANK FARM	43 x 73 x 24 H	43 x 73 x 24 H	—	43 x 73 x 24 H
INCINERATOR TANK FARM	81 x 65	81 x 65	81 x 65	—
TANK TRUCK UNLOADING BAY	30 x 82 x 6 clear	30 x 82 x 6 clear	30 x 40 x 6 clear	30 x 60 x 6 clear
INCINERATOR RECEIVING TANKS	25 x 30	25 x 30	25 x 30	—
MAINTENANCE WORKSHOPS & STORES	25 x 55 x 5.50 H	25 x 55 x 5.50 H	25 x 55 x 5.50 H	—
TRUCK WASH STATION	15 x 25 x 6 clear	15 x 25 x 6 clear	8 x 25 x 6 clear	8 x 25 x 6 clear
FIRE WATER POND	45 x 75 x 6 D	45 x 75 x 6 D	45 x 75 x 6 D	50 x 25 x 6 D
CLEAN STORM WATER HOLDING POND	45 x 75 x 6 D	45 x 75 x 6 D	45 x 45 x 6 D	45 x 45 x 6 D
POTENTIALLY CONTAMINATED WATER HOLDING POND	25 x 75 x 5 D	25 x 75 x 5 D	25 x 45 x 5 D	25 x 45 x 5 D
RAIL SPUR	3 wide	3 wide	3 wide	3m wide
AUXILIARY BOILER & FEEDWATER TREATMENT	12 x 32 x 14	12 x 32 x 14	12 x 32 x 14	—
STACK	100 H	100 H	100 H	—
DRUM CONVEYOR	3 wide	3 wide	3 wide	—
DRUM STORAGE & HANDLING BUILDING	9 above grade	9 above grade	9 above grade	72 x 62 x 6 clear
PIPE RACK	60 x 82 x 6 clear	90 x 82 x 6 clear	50 x 73 x 6 clear	3, 4 and 5 wide
ADMINISTRATION OFFICES	3, 4 and 5 wide	3, 4 and 5 wide	3, 4 and 5 wide	x 6 clear
CAR PARK	x 6 clear	x 6 clear	x 6 clear	25 x 40 x 7.70 H
GATEHOUSE & WEIGH SCALES	25 x 100 x 7.70 H	25 x 100 x 7.70 H	25 x 80 x 7.70 H	1850 m ²
EMERGENCY POWER GENERATION	4200 m ²	4200 m ²	2750 m ²	4x20 & 3x30 x 3 H
MAIN SUBSTATION	20 x 23 x 4.25 H	20 x 23 x 4.25 H	15 x 15 x 4.25 H	15 x 15 x 4.25 H
TRUCK HOLDING AREA	20 x 25	20 x 25	15 x 20	15 x 20
SOLIDIFICATION CURING AREA	25 x 120	25 x 120	25 x 70	25 x 60
	—	15 x 175	—	—

NOTES: 1. Dimensions in metres unless otherwise noted.

TABLE 2.4
SERVICES TO SITES

SERVICE	CASE 1 - INTEGRATED		
	LF-9C	LF-3C	LF-1E
Surface Water Drainage Discharge	To Sucker Creek (on site) 9440 t/day max.	To Beaver Creek (on site) 9440 t/day max.	Tributary to Lyons Creek (on site) 9440 t/day max.
Sanitary Sewage (See Note 1)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)
Water from Municipal System (Preferred)	Not Available	Not Available	From 12" Niagara Falls city main. 1518 t/day max.
Water from Watercourse (Alternative)	From Welland River 1518 t/day max.	From Welland River 1518 t/day max.	Not Required
Natural Gas (Preferred)	Not Available	Not Available	From Provincial Gas line on Montrose Rd 50 GJ/h
Fuel Oil (Alternative)	Delivery by tank truck 1650 t/a	Delivery by tank truck 1650 t/a	Not Required
Electric Power	From Ontario Hydro 115 kV.	From Ontario Hydro 115 kV.	From Niagara Falls Hydro Electric Commission 27.6 kV.
Telephone	From Bell line on Schram Rd.	From Bell line on Regional Rd. 16	From Bell line on Schisler Rd.

NOTES: 1. To be reviewed in Phase 4B.

TABLE 2.5
SERVICES TO SITES

SERVICE	CASE 2 - LANDFILL SEPARATE			
	PI - 1 N	PI - 13 N	LF - 4 N	PI - 27 E
Surface Water Drainage Discharge	Tributary to 16 Mile Creek. (on site) 3840 t/day max.	To East 16 Mile Creek. (on site) 3840 t/day max.	To Indian Creek. (on site) 5611 t/day max.	To Grassy Brook. (on site) 3840 t/day max.
Sanitary Sewage (See Note 2)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (11 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)
Water from Municipal System (Preferred)	From 12" Halton Region main. 1518 t/day max.	From 12" Halton Region main. 1518 t/day max.	From 12" Halton Region main. 11 t/day max.	From 12" Niagara Falls city main. 1518 t/day max.
Water from Watercourse (Alternative)	Not Required	Not Required	Not Required	Not Required
Natural Gas (Preferred)	From Union Gas line on Britannia Rd. W 50 G J/h	From Union Gas line on Britannia Rd. W 50 G J/h	Not Required	From Provincial Gas line on Montrose Rd. 50 G J/h
Fuel Oil (Alternative)	Not Required	Not Required	Not Required	Not Required
Electric Power	From Milton Hydro Electric Commission 27.6 kV	From Milton Hydro Electric Commission 27.6 kV	From Milton Hydro Electric Commission 27.6 kV	From Niagara Falls Hydro Electric Commission 27.6 kV
Telephone	From Bell line on First Line Rd.	From Bell line on Sixth Line	From Bell line on Britannia Rd. W	From Bell line on Biggar Rd.

- NOTES:** 1. For siting option LF-1E/PI-27E, services to LF-1E are the same as for LF-1E Case 1 except natural gas not required.
2. To be reviewed during Phase 4B.

TABLE 2.6
SERVICES TO SITES

SERVICE	CASE 3 - INCINERATOR SEPARATE			
	PI - 1 N	PI - 13 N	LF - 4 N	PI - 27 E
Surface Water Drainage Discharge	Tributary to 16 Mile Creek. (on site) 2200 t/day max.	To East 16 Mile Creek. (on site) 2200 t/day max.	To Indian Creek. (on site) 7800 t/day max.	To Grassy Brook. (on site) 2200 t/day max.
Sanitary Sewage (See Note 2)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)	Treated on site. Discharged with surface drainage. (12 t/day incl.)	Treated on site. Discharged with surface drainage. (24 t/day incl.)
Water from Municipal System (Preferred)	From 12" Halton Region main. 120 t/day max.	From 12" Halton Region main. 120 t/day max.	From 12" Halton Region main. 1518 t/day max.	From 12" Niagara Falls city main. 120 t/day max.
Water from Watercourse (Alternative)	Not Required	Not Required	Not Required	Not Required
Natural Gas (Preferred)	From Union Gas line on Britannia Rd. W 50 G J/h	From Union Gas line on Britannia Rd. W 50 G J/h	From Union Gas line on Britannia Rd. W 50 G J/h	From Provincial Gas line on Montrose Rd. 50 G J/h
Fuel Oil (Alternative)	Not Required	Not Required	Not Required	Not Required
Electric Power	From Milton Hydro Electric Commission 27.6 kV	From Milton Hydro Electric Commission 27.6 kV	From Milton Hydro Electric Commission 27.6 kV	From Niagara Falls Hydro Electric Commission 27.6 kV
Telephone	From Bell line on First Line Rd.	From Bell line on Sixth Line	From Bell line on Britannia Rd.W	From Bell line on Biggar Rd.

- NOTES:** 1. For siting option PI-27E/LF-1E, services to LF-1E are the same as for LF-1E Case 1
2. To be reviewed in Phase 4B.

CHAPTER 3
REFINEMENT OF SITING OPTIONS

3.1 INTRODUCTION

This chapter describes engineering input to the refinements that were required prior to conducting the final comparative evaluation of siting options. These refinements included the following:

- Refinement of Site Boundaries - this analysis reviewed the three largest candidate sites (LF-3C, LF-1E and PI-1N) to determine the feasibility of reducing their site areas in order to minimize impacts.
- Access Roads - this analysis identified the preferred access routes from the 400 Series Highways to each siting option and the intersite transfer routes between partially integrated siting options.
- Rail Access - this analysis reviewed the feasibility of and selected a preferred route for a rail spur to each candidate site.
- Location of Physical/Chemical Treatment Plant - this analysis reviewed, for the three partially integrated siting options, preferences in terms of risk, impact and engineering considerations of locating the physical/chemical treatment plant with the engineered landfill or with the incineration plant.

The overall process of analysis and the results are detailed in the reports "Background Material for the OWMC Phase 4A Site Selection Workshops Volumes 1 & 2" (Ref: OWMC22) and "Site Selection Process. Phase 4A: Selection of a Preferred Site(s) - Site Selection" (Ref: MMD16).

3.2 REFINEMENT OF SITE BOUNDARIES

Phase 3 of the Facilities Development Process had identified potential site acquisition areas for the candidate sites and noted that in some cases, site acquisition areas might be larger than necessary to accommodate OWMC's Treatment Facility (Ref: OWMC21). The three largest sites (LF-3C, LF-1E and PI-1N) were reviewed in Phase 4A to determine if they could be further reduced in size in order to minimize impacts (Ref: MMD16).

The site boundary refinement analysis undertaken by the site selection team used a constraint mapping approach. This technique identified constraints such as floodplains, geologic and hydrogeologic features, biological features, high quality agricultural land etc. The site boundaries were then modified to avoid constrained areas as far as possible while still providing adequate site area for the Facility.

Monenco's input to the constraint mapping exercise was to confirm that the Facility, including the technical buffer zone, could be accommodated within the site acquisition boundary in accordance with:

- factor - Site Area, and
- indicator - Site Size
 - Landfill Life

as defined in Appendix A.

The methodology used to confirm this was to superimpose the relevant 1:10 000 scale drawing of the central operating and technical buffer zone, Figures 2.1, 2.2, 2.3 and 2.4 (pp 41 to 45), onto the 1:10 000 scale constraint map of the site developed by the site selection team. It was then confirmed that the technical buffer zone was contained within the site acquisition boundary.

In respect of landfill life, at the time the boundaries were refined, landfill life estimates did not include Phase 4A hydrogeologic and/or geotechnical constraints as detailed in Chapter 4 (pp 74, 75, 86) and a minimum landfill life of 20 years appeared feasible. It was therefore decided, for candidate sites LF-3C and LF-1E, to maintain the boundary areas remaining after constraint mapping (Ref: MMD16), subject to the results of the Phase 4A drilling program (Ref GLAL⁷).

Subsequent to the refinement of site boundaries, the results of the Phase 4A drilling program (Ref: GLAL⁷) were incorporated into the landfill life estimates (p. 111), which reduced the landfill life potential. As a result, further refinement of site boundaries at LF-3C and LF-1E was considered as part of the sensitivity analysis conducted during the comparative evaluation of siting options described in Chapter 6 (pp 122).

The resultant conceptual site layouts are shown on the following drawings in Appendix D:

<u>Candidate Site</u>	<u>Siting Option</u>	<u>Figure No.</u>
LF-3C	Case 1 - Integrated	D.10
LF-1E	Case 1 - Integrated	D.12
LF-1E	Case 2 - Landfill Separate	D.20
LF-1E	Case 3 - Incinerator Separate	D.30
PI-1N	Case 2 - Landfill Separate	D.15
PI-1N	Case 3 - Incinerator Separate	D.23

3.3 ACCESS ROADS

This analysis resulted in the identification of the preferred access routes from the 400 Series Highways to each siting option and the intersite transfer routes between siting options.

Monenco's input was to confirm that the facility layouts (Figures D.1, D.2, D.3, D.4 and D.5 in Appendix D) could be oriented on the sites such that the entrance to the Facility matched the access road location, as shown on "Site Layout" Figures in Appendix D. In addition, the "Site Layout" figures show a proposed secondary access to each site for emergency vehicles.

3.4 RAIL ACCESS

The provision of rail access to a candidate site is viewed as an opportunity to reduce potential impacts and costs rather than as an absolute requirement of facility design and operation. Rail service is considered useful for the possible haulage of process additives and reagents which could be received in large bulk shipments at the Facility. The analysis resulted in the identification of sites where rail access was feasible and also selected the preferred rail access to those sites.

For the candidate sites where rail access was determined to be feasible (Ref: MMD16), preliminary site layouts were prepared which incorporated a rail spur from the Facility to the nearest rail line, using the most direct route. These layouts were used as a starting point by the site selection team for the rail access analysis.

Additional options were then identified for consideration (Ref: MMD16) and where possible, the rail access options followed existing property ownership boundaries.

Monenco's input was to confirm that the facility layouts (Figures D.1, D.2, D.3, D.4 and D.5 in Appendix D) could be oriented on the sites to accommodate the alternative rail access locations under consideration and the preferred access road identified in Section 3.3 (p. 55).

In addition a qualitative assessment of the relative differences between the various rail access options at each candidate site including a ranking from an engineering perspective, was undertaken. The results are presented in Tables 3.1 to 3.6.

The preferred rail access for each siting option is shown on "Site Layout" figures in Appendix D.

3.5 LOCATION OF PHYSICAL/CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS

The seven candidate sites remaining after the rejection of LF-2N (Ref: MMD18) reduced the number of siting options to three fully integrated and six partially integrated siting options.

An integrated siting option consists of the engineered landfill, the physical/chemical treatment plant (including solidification) and the incineration plant all located on one candidate site (Case 1 siting option).

A partially integrated siting option consists of a combination of two candidate sites, with the engineered landfill located on the LF site, the incineration plant located on the PI site and a choice of locating the

physical/chemical treatment plant (including solidification) on either site. Location of the physical/chemical treatment plant (including solidification) with the incineration plant is referred to as a Case 2 siting option, whereas locating the physical/chemical treatment plant (including solidification) with the engineered landfill is referred to as a Case 3 siting option.

The partially integrated siting options identified by OWMC (Ref: OWMC 21) are as follows:

- LF-4N/PI-1N

- Option 1, the engineered landfill at LF-4N and the incineration plant and physical/chemical treatment plant (including solidification) at PI-1N (Case 2).
- Option 2, the engineered landfill and physical/chemical treatment plant (including solidification) at LF-4N and the incineration plant at PI-1N (Case 3).

- LF-4N/PI-13N

- Option 1, the engineered landfill at LF-4N and the incineration plant and physical/chemical treatment plant (including solidification) at PI-13N (Case 2).
- Option 2, the engineered landfill and physical/chemical treatment plant (including solidification) at LF-4N and the incineration plant at PI-13N (Case 3).

- LF-1E/PI-27E

- Option 1, the engineered landfill at LF-1E and the incineration plant and physical/chemical treatment plant (including solidification) at PI-27E (Case 2).
- Option 2, the engineered landfill and physical/chemical treatment plant (including solidification) at LF-1E and the incineration plant at PI-27E (Case 3).

Figure 3.1 is a schematic which illustrates the conceptual arrangement of the two partially integrated siting options. These two options were characterized by information provided in Chapter 2 of this report, and this information was used by the site selection team in establishing risks, impacts and costs for comparison in its assessment of the two alternative locations for the physical/chemical treatment plant.

Monenco's input to this analysis is summarized on Table 3.7 and was compiled by means of the following factors:

- factor capital cost,
 - factor operating cost, and
 - factor site size, indicator landfill life
- as defined in Appendix A.

The capital cost is the total estimated capital cost of an OWMC Treatment Facility with a capacity of 300 000 t/a located at the respective siting option, as discussed in Chapter 5 (pp 88 to 96) and Table E.2 of Appendix E. The main component which determines the difference in capital cost between a Case 2 and Case 3 siting option is the indicator "On-Site Facilities", which addresses the extra costs associated with the duplication of certain facilities at a Case 3 siting option, as identified in Table 2.3, (p. 48), such as:

- tank truck unloading bay,
- fire water pond,
- clean storm water holding pond,
- potentially contaminated water holding pond,
- pipe rack,
- administration offices (including laboratory),
- gatehouse and weigh scales,
- emergency power generation,
- main substation, and
- roads, paved areas and fencing.

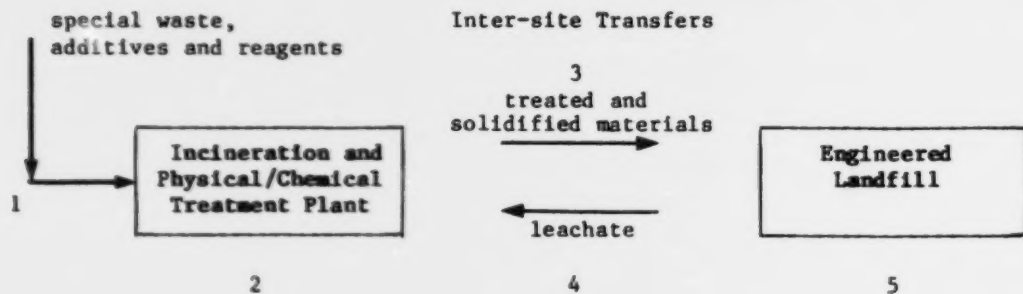
The operating cost is the estimated annual cost of operating OWMC's Treatment Facility at 300 000 t/a capacity at the respective siting option, as discussed in Chapter 5 (pp 97 to 103) and Table E.4 of Appendix E. The major differences in operating cost between a Case 2 and Case 3 siting option are increased fixed operating costs, operating labour and utilities at a Case 3 siting option.

The landfill life is the estimated landfill life of OWMC's Treatment Facility at the respective siting options, as discussed in Chapter 6 (pp 105 to 111). The decrease in landfill life associated with a Case 3 siting option is due to the physical/chemical treatment facility, when it is located with the engineered landfill, using up site area which would otherwise be available for landfilling.

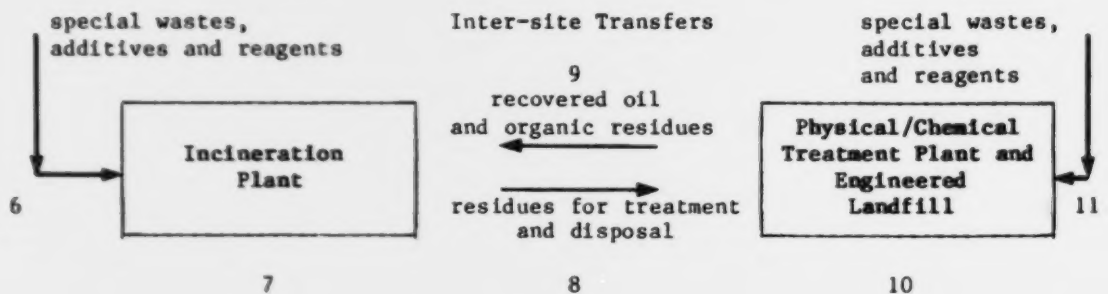
FIGURE 3.1

SCHEMATIC OF PARTIALLY INTEGRATED SITING OPTIONS

OPTION 1: The physical/chemical treatment plant (including solidification) with the incineration plant and the engineered landfill on a separate site.



OPTION 2: The physical/chemical treatment plant (including solidification) with the engineered landfill and the incineration plant on a separate site.



LEGEND

- 1 = access route for transporting - special waste, additives and reagents to the incineration and physical/chemical treatment plants
- 2 = site of the incineration and the physical/chemical treatment plants
- 3 = inter-site transfer route for the treated and solidified materials from the incineration and physical/chemical treatment plants to the engineered landfill
- 4 = inter-site transfer of leachate from the engineered landfill to the physical/chemical treatment plant
- 5 = site of the engineered landfill
- 6 = access route for transporting special wastes and additives and reagents to the incineration plant
- 7 = incineration plant site
- 8 = inter-site transfer route for transporting residues from the incineration plant to the physical/chemical treatment plant and engineered landfill
- 9 = transfer route for transporting recovered oil and organic residues from the physical/chemical treatment plant to the incineration plant
- 10 = site of the physical/chemical treatment plant and engineered landfill
- 11 = access route for transporting special waste, additives and reagents to the physical/chemical treatment plant

TABLE 3.1

LF-9C

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTIONS				
				1	2	3	4*	5
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on N-S axis	Facility oriented on N/S axis	Facility oriented on N/S axis	Facility oriented on N/S axis	Facility oriented on N/S axis
		SITE AREA LANDFILL LIFE	Least interference with landfill development	Interferes with landfill development	Interferes with landfill development	Interferes with landfill development	Minimal interference w/ landfill development	Minimal interference w/ landfill development
		CAPITAL COST	OFF-SITE FACILITIES	Long rail spur required	Long rail spur required	Longest rail spur required	Short rail spur required	Shortest rail spur required
RANKING				3	4	4	2	1

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD¹⁶).

RANKING RATIONALE

- Site constraints permit plant layout on N-S axis only (p. 72).
- Options 1, 2 and 3 require longer rail spur than options 4 and 5.
- Option 5 marginally better than option 4 in terms of site layout.

- * Preferred option for Phase 4A comparative evaluation (Ref: MMD¹⁶).

TABLE 3.2

LF-3C

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTIONS		
				1	2*	3
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on E-W axis	Facility oriented on E-W axis	Facility oriented on N-S axis
		SITE AREA	LANDFILL LIFE	Least interference with landfill development	Least interference with landfill development	Interferes with landfill development
		CAPITAL COST	OFF-SITE FACILITIES	Shortest rail spur required	Shortest rail spur required	Long rail spur req'd and has to cross a flood plain
RANKING				1	1	2

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD¹⁶).

RANKING RATIONAL

- Option 3 requires longest rail spur and rail spur has to cross a flood plain.
- Options 1 and 2 are ranked equal from an engineering perspective.
- * Preferred option for Phase 4A comparative evaluation (Ref: MMD¹⁶).

TABLE 3.3

LF-1E

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTIONS			
				1*	2	3	4
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on E-W axis	Facility oriented on E-W axis	N/A	N/A
		SITE AREA	LANDFILL LIFE	Least interference with landfill development	Interferes with landfill development	N/A	N/A
		CAPITAL COST	OFF-SITE FACILITIES	Shortest rail spur required	Long rail spur required	N/A	N/A
RANKING				1	2	N/A	N/A

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD16).

RANKING RATIONALE

- Options 3 and 4 excluded from engineering analysis (Ref: MMD16).
- Option 2 requires longer rail spur than Option 1.

* Preferred option for Phase 4A comparative evaluation (Ref: MMD16).

TABLE 3.4

LF-4N

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTIONS			
				1*	2	3	4
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on E-W axis	Facility oriented on N-S axis	Facility oriented on E-W axis	Facility oriented on N-S axis
		SITE AREA	LANDFILL LIFE	Least interference with landfill development	Interferes with landfill development	Interferes with landfill development	Interferes with landfill development
		CAPITAL COST	OFF-SITE FACILITIES	Shortest rail spur required	Long rail spur required	Short rail spur req'd but has to cross flood plain area	Rail spur has to cross low lying swampy area
RANKING				1	2	2	2

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD¹⁶).

RANKING RATIONALE

- Options 2, 3 and 4 have more interference with landfill development than Option 1.
- Options 3 and 4 cross flood prone or swampy areas.

* Preferred option for Phase 4A comparative evaluation (Ref: MMD¹⁶).

TABLE 3.5

PI-1W

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTIONS			
				1	2*	3	4
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on N-S axis	Facility oriented on N-S axis	Facility oriented on N-S axis	Facility oriented on N-S axis
		SITE AREA	LANDFILL LIFE	N/A	N/A	N/A	N/A
		CAPITAL COST	OFF-SITE FACILITIES	Longer rail spur required	Shortest rail spur required	Short rail spur required	Short rail spur required
RANKING				3	1	2	2

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD16).

RANKING RATIONALE

- Option 1 has marginally longer rail spur than Options 3 and 4.
- Options 3 and 4 have marginally longer rail spur than Option 2.

- * Preferred option for Phase 4A comparative evaluation (Ref: MMD16).

TABLE 3.6

PI-27E

RAIL ACCESS OPTIONS - QUALITATIVE ASSESSMENT

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	RAIL ACCESS OPTION	
				1*	
SITE	ENGINEERING	SITE AREA	SITE SIZE	Facility oriented on E-W axis	
		SITE AREA	LANDFILL LIFE	N/A	
		CAPITAL COST	OFF-SITE FACILITIES	Shortest rail spur required	
RANKING					

NOTE:

- Rail access options are defined in M.M. Dillon's report (Ref: MMD16).

RANKING RATIONALE

- Option 1 was the only option considered.
- * Preferred option for Phase 4A comparative evaluation (Ref: MMD16).

TABLE 3.7

**LOCATION OF PHYSICAL/CHEMICAL TREATMENT PLANT
FOR PARTIALLY INTEGRATED SITING OPTIONS**

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	SITING OPTIONS					
				LF-4N/PI-1N		LF-4N/PI-13N		LF-1E/PI-27E	
				CASE 2*	CASE 3	CASE 2*	CASE 3	CASE 2*	CASE 3
SITE	ENGINEERING	CAPITAL COST	TOTAL ESTIMATED COST	190382	207027	191512	208157	194002	213743
		OPERATING COST	YEAR 10 OPERATING COST	42295	43578	42536	43691	46398	47946
		SITE AREA	LANDFILL LIFE (YEARS) TOTAL SOLIDIFICATION	15.5	11.5	15.5	11.5	11	9.5
			RANKING	1	2	1	2	1	2

NOTE:

- All costs shown in 1984 thousand dollars (Canadian).

OPTION DEFINITION

- Case 2 (Landfill Separate) - the physical/chemical treatment plant (including solidification) is located with the incineration plant on the PI site with the engineered landfill on a separate LF site.
- Case 3 (Incinerator Separate) - the physical/chemical treatment plant (including solidification) is located with the engineered landfill on the LF site with the incineration plant on a separate PI site.

RANKING RATIONALE

- For each siting option, Case 2 (Landfill Separate) has a lower capital and operating cost and a longer landfill life than Case 3. (Incinerator Separate).
- * Preferred option for Phase 4A comparative evaluation (Ref: MND16).

CHAPTER 4
ENGINEERING SPECIFIC TO EACH SITE

4.1 INTRODUCTION

The refinement of siting options described in Chapter 3 reduced the number of siting options to three fully integrated and three partially integrated siting options, by deletion of the three partially integrated siting options involving a separate incineration plant (Case 3), (Ref: MMD¹⁶). The remaining siting options are as follows:

- Case 1 - Integrated Siting Options
 - LF-9C
 - LF-3C
 - LF-1E

- Case 2 - Landfill Separate Siting Options
 - LF-4N with PI-1N
 - LF-4N with PI-13N
 - LF-1E with PI-27E

The refinement analyses also established the site acquisition boundaries, preferred access roads and rail access to be used in the comparative evaluation (Ref: MMD¹⁶).

This chapter discusses the engineering adaptations specific to each candidate site which were developed for, or as an outcome of, the basic acceptability analysis. In addition, variable and constraining features of each site are addressed.

Basic acceptability is an analysis, performed by each member of the site selection team, to determine whether the more detailed information available in Phase 4A had revealed any severe constraints which might preclude further consideration of a particular site.

Section 4.2 discusses our input to Gartner Lee Associates Limited's basic acceptability analysis which resulted in the rejection of LF-2N. Monenco's comparative evaluation of siting options (pp 104 to 135) did not include LF-2N due to this rejection (p. 13).

Variable and constraining features are specific items, identified by the site selection team, which have an effect on the engineering design and/or total estimated capital cost for each siting option. Figure 5.1, in Chapter 5 (p. 96) of this report, illustrates that, on average, 89 percent of the total estimated capital cost is made up of items which are common to all siting options. The variable and constraining features identified in this chapter account for the remaining 11 percent of the total estimated capital cost.

4.2 BASIC ACCEPTABILITY

With the exception of Gartner Lee Associates Limited, none of the other members of the site selection team identified any constraints severe enough to warrant a site being precluded from further consideration by reason of its failure to pass a basic acceptability screen.

Four sites - LF-2N, LF-4N, PI-1N and PI-13N - were identified by Gartner Lee Associates Limited (Ref: GLAL⁷) as having potential hydrogeologic constraints, based on the facility characteristics information for potential spills and leaks identified in Section 2.2.3.2 Engineered Containment (p. 31).

Gartner Lee Associates Limited (Ref: GLAL⁷) then proposed certain design modifications which they considered to have the greatest potential for

maximizing natural containment. Monenco agreed with these modifications and accommodated them in the design of the Facility (pp 73 to 76).

Further analysis of the constraints at these four sites by Gartner Lee Associates Limited revealed that LF-2N, in Mississauga, could not satisfy the criteria for natural containment even after the facility design modifications had been incorporated. A decision was therefore made to eliminate LF-2N from any further consideration (Ref: MMD¹⁶ and MMD¹⁸).

From an engineering perspective, Monenco's basic acceptability analysis revealed that only one site, LF-9C in West Lincoln, was severely constrained. When the initial modular layout developed for an integrated siting option (Figure D.1 in Appendix D) was superimposed on this site, it was found that the 400 metre technical buffer zone, as shown on Figure 2.1 (p. 41), extended outside the site acquisition boundary. The layout of the central operating area had to be modified, as shown on Figures 2.5 (p. 45), D.5 and D.8 in Appendix D, so that the technical buffer zone could be contained within the site acquisition boundary. This modification is discussed further in Section 4.3.1 (p. 71).

4.3 VARIABLES AND CONSTRAINING FEATURES

The following variable and constraining features were identified, although not all of these features were either variable or constraining at every siting option:

- Area of site land parcel.
- Size and layout of process areas.
- Foundation and structure design.
- Landfill cell dimensions.
- Landfill area restrictions.
- Services.
- Off-site drainage improvements.

- Off-site road improvements.
- Rail access.
- Mitigative measures.

A discussion of these features and their effects on the cost of the Facility follows, including a site-by-site summary in Tables 4.1 to 4.8 (pp 79 to 86).

4.3.1 AREA OF SITE LAND PARCEL

The factor "Site Area" and the indicator "Site Size", included in Appendix A, define the basic requirements for the area of the site land parcel.

The Facility consists of a central operating area with its associated 400 m technical buffer zone, and an engineered landfill with its 50 m buffer zone. These are both located on one site for the Case 1 - Integrated siting options, and separately for the Case 2 - Landfill Separate siting options. M.M. Dillon Limited (Ref: MMD¹⁵) identified the requirement for the 400 m technical buffer zone measured from the source of potential emissions within the central operating area (p. 33), and the 50 m buffer zone around the engineered landfill to be contained within the site acquisition boundary.

Gartner Lee Associates Limited (Ref: GLAL⁷) identified two sites where hydrogeologic constraints restricted the location of the central operating area within the site acquisition boundary. The areas identified for development on each site were:

- LF-1E - north half of the site, and
- PI-27E - south east half of the site.

The location of the central operating area at PI-27E was further restricted by the ConRail track and hydro powerline which diagonally bisect the site.

M.M. Dillon Limited (Ref: MMD¹⁷) identified a constraint at PI-1N in respect of the location of the incinerator stack in relation to the flight path from Burlington Airpark nearby.

The appropriate 1:10 000 scale layouts of the central operating area (including the technical buffer zone), as shown on Figures 2.1 and 2.2 (pp 41, 42), were superimposed on 1:10 000 scale maps of each candidate site, oriented to suit the preferred road and rail access and located in accordance with the constraints identified above. The results of this procedure are shown on the "Site Layout" Figures in Appendix D.

On one site (LF-9C) the technical buffer zone extended beyond the east/west site boundaries. The Case 1 layout shown in Figure D.1 of Appendix D was modified as shown in Figure D.5, of Appendix D and the corresponding 1:10 000 scale layout of the central operating area (including the technical buffer zone) Figure 2.5 (p. 45). This arrangement permitted the technical buffer zone to be contained within the site boundaries as shown on Figure D.8 in Appendix D.

All siting options were then judged to have satisfied the criteria for "Site Size" as defined in the Factor Sheets in Appendix A.

4.3.2 SIZE AND LAYOUT OF PROCESS AREAS

The size of each process area is the same for all Case 1 and Case 2 siting options, with the following exceptions:

- Case 2 PI sites require a solidification curing area (as shown on Figure D.2 of Appendix D) for storing, curing and handling of solidified material prior to its transport to the engineered landfill site. The operation of the Case - 2 Landfill Separate siting options is such that the solidification plant can operate up to 3 shifts/day, 5 days/week whereas the engineered landfill will only operate 1 shift/day, 5 days/week. Therefore, the solidified material produced during the second and third shifts must be stored at the PI

site and then transported to the the LF site for placement in the engineered landfill during the day shift. All three Case 2 PI sites will require a similar curing area.

- Sites LF-9C and LF-3C require storage capacity for fuel oil for use as start-up and supplementary fuel at the incinerator plant, and for fuelling the auxiliary boilers. Natural gas is not available to these sites.

The arrangement of the buildings within the central operating area is as shown in Figure D.1 of Appendix D for Case 1 sites and Figure D.2 of Appendix D for Case 2 sites. The layout is the same for both cases with the exceptions already noted and the following:

- LF-9C layout has been rearranged as shown in Figure D.5 of Appendix D to accommodate the technical buffer zone within the site boundary.
- LF-9C, LF-1E and PI-27E facility entrance areas have been modified to accommodate the preferred access road location.

4.3.3 FOUNDATION AND STRUCTURAL DESIGN

The structures of the Facility and their foundations are affected by particular site conditions as further explained below:

- The load-bearing capacity of the subsurface material varies from one site to another. A separate report by Gartner Lee Associates Limited (Ref: GLAL⁷) recommends the foundation types, including lengths of piles, based on preliminary loadings supplied by Monenco. The main difference is that the central and eastern sites require piled foundations, while the northern ones do not.
- The subsurface material also varies from one site to another in its ability to provide natural containment, a requirement for the basic acceptability analysis of Gartner Lee Associates Limited (Ref: GLAL⁷). Under the central operating area of sites PI-1N and

PI-13N, the 8 m excavation identified in the facility characteristics information, Section 2.2.3.2 (p. 31), could be expected to locally penetrate the confining layer (Ref: GLAL⁷). Gartner Lee Associates Limited (as part of their basic acceptability analysis) proposed modifying the depth of excavation within the central operating area of these sites be limited to 5 m to avoid penetrating the confining layer (Ref: GLAL⁷). This could be achieved by backfilling the portion of the site occupied by the central operating area with a 3 m layer of soil to raise the elevation of the foundations relative to the confining layer. OWMC accepted this recommendation and the engineering design at PI-1N and PI-13N was modified accordingly. This modified design was used by Gartner Lee Associates (Ref: GLAL⁷) in their basic acceptability analysis (pp 69, 70).

- The National Building Code of Canada requires that the Facilities located on the central and eastern sites be designed for a higher probability of earthquake (Zone 2) than for the northern sites (Zone 1). This is achieved by strengthening of the structural frames of buildings and foundations at the Zone 2 sites.

4.3.4 LANDFILL CELL DIMENSIONS

The "Status Report-Facility Design" (Ref: MONENCO¹⁹) illustrates a conventional landfill cell with cross-sectional dimensions 100 m wide, an excavation 10 m deep, and solidified material mounded to a height of 12 m above the original ground level.

The Gartner Lee Associates Limited report (Ref: GLAL⁷), describes two types of constraint which may affect the vertical dimensions of the cells. These are:

- hydrogeologic, and
- geotechnical.

A hydrogeologic constraint occurs where the natural containment potential of the subsurface material precludes excavation of the cells to the

full 10 m depth. The effect of this constraint is to require placement of the solidified material in a shallower (for example, 5 m) excavation.

A geotechnical constraint occurs where the subsurface material is highly compressible when loaded. In such cases, loading the existing ground with the weight of a mound of solidified material 12 m high may result in unacceptably high or uneven settlement of the ground. The effect of this constraint is to limit the height to which the solidified material may be mounded.

These constraints do not directly affect the lateral or longitudinal dimensions of the cells. An indirect effect is to modify the dimensions to make a vertically constrained cell large enough in volume to accept six months production of solidified material when the Facility is operating at 300 000 t/a capacity.

The constraints identified above affect landfill cell dimensions at all sites. The modified vertical dimensions of the landfill cells are shown in Table 4.8 (p. 86).

4.3.5 LANDFILL AREA RESTRICTIONS

The sites identified for landfilling may have some restrictions which preclude the use of certain areas on the site. These restrictions were identified as:

- hydrogeologic, and
- flood prone areas.

Hydrogeologic restrictions apply to areas of the site where the confining layer could be expected to be penetrated by excavation for the Facility or areas where the potential to provide natural containment is limited, both of which affect the basic acceptability analysis of Gartner Lee Associates Limited (Ref: GLAL⁷). Sites LF-4N and LF-1E are so restricted, as shown on "Site Layout" Figures in Appendix D.

At LF-4N, the landfill cells were restricted to areas of the site where the depth of clay was at least 15 m. This modified design was used by Gartner Lee Associates Limited (Ref: GLAL⁷) in their comparative evaluation analysis (p. 69).

At LF-1E, the landfill cells were restricted to the northern and western portions of the site.

Flood prone areas have generally been avoided when selecting the land parcels for the candidate sites. There are still, however, minor streams which cross some sites. A report by Gartner Lee Associates Limited (Ref: GLAL⁸) examines the drainage patterns on and adjacent to the sites and recommends measures required for redirection of streams around the site perimeters.

Only one site, LF-3C, was identified as having a watercourse (Beaver Creek) which cannot be redirected, (Ref: GLAL⁸) and a 200 m floodplain zone has been designated each side of Beaver Creek which would not be used for landfill purposes.

4.3.6 SERVICES

The services which must be connected to the candidate sites are:

- surface water drainage discharge (clean storm water),
- sanitary sewage,
- water from municipal system (potable water),
- water from watercourses (raw water),
- natural gas,
- electrical power, and
- telephone.

Services have been routed to the sites within existing road allowances.

With the exception of LF-9C and LF-3C, a source of water is available from the local municipality/region, although the Milton sites require a booster pumping station. At LF-9C and LF-3C, the source of water is assumed to be the Welland River (Ref: GLAL⁸), requiring a pump house at the river and additional water treatment capacity at the sites.

Where natural gas is unavailable (LF-9C and LF-3C), storage capacity for oil has been provided.

Points of discharge for surface water drainage were provided by Gartner Lee Associates Limited (Ref: GLAL⁸). All other service connections were obtained by discussion with hydro, gas and telephone companies, and local municipalities.

Service connections to and from the sites are listed in Chapter 2, Tables 2.3 and 2.4 (pp 48, 49), and are shown on Figures "Service Connections" in Appendix D.

4.3.7 OFF-SITE DRAINAGE IMPROVEMENTS

The requirement and associated costs for this work were provided by Gartner Lee Associates Limited (Ref: GLAL⁸).

4.3.8 OFF-SITE ROAD IMPROVEMENTS

M.M. Dillon Limited (Ref: MMD¹⁷) identified the necessity for improvements to local and regional access roads. This was based on the impact of OWMC generated truck traffic on the road's estimated traffic and road conditions in the year 2000, when the OWMC Treatment Facility is expected to be processing 300 000 t/a of special waste. The costs of improving the existing preferred access roads to the candidate sites, as well as any additional land requirements to accommodate the improvements, were provided by M.M. Dillon Limited (Ref: MMD¹⁷).

The cost of the additional land was provided by Graydon Rogers Appraisals Limited (Sub-consultant to Leon Kentridge Associates Limited).

4.3.9 RAIL ACCESS

Facility site layouts include provision of a rail spur for transporting bulk additives and reagents consistent with the work on rail access described in Chapter 3 (Ref: MMD¹⁶). However, the use of rail has not been included in our cost analysis but has been included in a sensitivity analysis described in Chapter 6 (p. 121).

4.3.10 MITIGATIVE MEASURES

During this phase of the site selection process, constraints identified by other members of the site selection team required modification to the engineering design as discussed earlier in this chapter.

Mitigative measures are additional measures to lessen impacts associated with the location and operation of OWMC's Treatment Facility. Two such measures were identified (Ref: MMD¹⁶) and costs provided to Monenco for inclusion in the total estimated capital costs, as follows:

- Construction of a cattle crossing under Krick Road, on the preferred access road to LF-3C (Ref: MMD¹⁷).
- Excavation of archaeological sites located within the site acquisition boundaries of the Facility prior to construction (Ref: GLAL⁹).

4.3.11 OTHER

At LF-9C, Bell Canada has an easement for a utility corridor, to accommodate buried telephone cables, which bisects the site east to west. This utility corridor will require relocation and the abandoned cables removed prior to construction of the facility.

TABLE 4.1
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE LF-9C

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.8, Appendix D.
	Area	135 ha
	Constraint on Layout	Modular layout revised to keep buffer zone limits within site boundary.
Size and Lay-out of Process Areas	Drawing Revised	Figure D.5, Appendix D. Used as integrated siting option. Layout completely revised to suit buffer zone. Oil storage required. Entrance oriented to suit preferred access road.
Foundation and Structure Design	Piling	Required for all structures.(Ref:GLAL ⁷)
	Earthquake	Design for Zone 2.
Landfill cell Dimensions	Height	4 m See Table 4.8 (Ref: GLAL ⁷)
	Depth	10 m See Table 4.8 (Ref: GLAL ⁷)
Landfill Area Restrictions		None
Services	Drawing	Figure D.9, Appendix D.
	Table	Table 2.4, Chapter 2.
	Constraint	Natural gas and municipal water not available.
Off-Site Drainage	Improvements	Required. (Ref:GLAL ⁸).
Off-Site Access Road	Improvements	Required. (Ref: MMD ¹⁷).
Rail Access	Drawing	Figures D.8, D.9, Appendix D. (Ref: MMD ¹⁶)
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹)
Other		Bell Canada buried cables bisect site east to west and will require rerouting before construction of Facility.

TABLE 4.2
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE LF-3C

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.10, Appendix D
	Area	206 ha
Size and Lay-out of Process Areas	Drawing	Figure D.1, Appendix D Used as integrated siting option. Oil storage required.
Foundation and Structure Design	Piling	Required for all structures (Ref: GLAL ⁷)
	Earthquake	Design for Zone 2.
Landfill Cell Dimensions	Height	4 m See Table 4.8 (Ref: GLAL ⁷)
	Depth	10 m See Table 4.8 (Ref: GLAL ⁷)
Landfill Area Restrictions	Floodplain	200 m floodplain adjacent to Beaver Creek will not be landfilled. (Ref: GLAL ⁸)
Services	Drawing	Figure D.11, Appendix D
	Table	Table 2.4, Chapter 2
	Constraint	Natural gas and municipal water not available.
Off-Site Drainage	Improvements	Required. (Ref: GLAL ⁸)
Off-Site Roads	Improvements	Required. Ref: MMD ¹⁷)
Rail Access	Drawing	Figures D.10, D.11, Appendix D. (Ref: MMD ¹⁶)
Mitigation		Cattle crossing under Krick Road. (Ref: MMD ¹⁷)
		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹).
Other		None

TABLE 4.3
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE LF-1E

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figures D.12, D.20, Appendix D.
	Area	273 ha for integrated site. 135 ha for partially integrated siting option.
	Constraint on Layout	See "Other" below
Size and Lay-out of Process Areas	Drawing Revised	Figures D.1, D.2, Appendix D. Used as integrated site and for landfill separate siting option when combined with PI-27E. Entrance oriented to suit preferred access road and rail access.
Foundation and Structure Design	Piling	Required for all structures (Ref: GLAL ⁷)
	Earthquake	Design for Zone 2.
Landfill Cell Dimensions	Height	1.5 m See Table 4.8 (Ref: GLAL ⁷)
	Depth	5 m See Table 4.8 (Ref: GLAL ⁷)
Landfill Area Restrictions	Hydrogeologic	Restricted in South and East. See Figures D.12, D.20 (Ref: GLAL ⁷)
Services	Drawing	Figures D.13, D.22, Appendix D
	Table	Tables 2.4, 2.5, Chapter 2
Off-Site Drainage	Improvements	Required. (Ref: GLAL ⁸)
Off-Site Roads	Improvements	Required. (Ref: MMD ¹⁷)
Rail Access	Drawing	Figures D.12, D.13, Appendix D. (Ref: MMD ¹⁶).
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹)
Other	Hydrogeologic	Location of Facility restricted to north half of site (Ref: GLAL ⁷).

- Off-site drainage improvements - Gartner Lee Associates Limited (Ref: GLAL⁸).
- Telephone connections - Bell Canada.
- Electrical connections - Ontario Hydro or local authority.

5.2.3 PRESENTATION OF CAPITAL COST ESTIMATES

The capital costs for the 300 000 t/a capacity Facility at the six siting options are presented in Table 5.1. It will be noted that the difference between the highest (LF-1E/PI-27E) and the lowest cost siting option (LF-3C) is only approximately 2 1/2%.

The small difference in capital cost between the various siting options is more easily appreciated when it is recognized that only a small percentage of the total capital cost for each siting option actually varies from site to site. Figure 5.1 illustrates that about 11% of the capital cost varies from site to site, where as the remaining 89% remains constant.

Summary tables included in Appendix E present the capital costs of both the 150 000 t/a (Table E.1) and 300 000 t/a (Table E.2) Facilities for all nine siting options remaining after the exclusion of candidate site LF-2N. The 300 000 t/a estimates were used as an input to the selection of a preferred location of the physical/chemical treatment plant (Case 2 or Case 3), as described in Chapter 3 (pp 56 to 60, 67).

TABLE 4.4
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE PI-1N

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.15, Appendix D.
	Area	175 ha
	Constraint on Layout	Incinerator stack location is impacted by flight path from Burlington Airpark (Ref: MMD ¹⁷)
Size and Lay-out of Process Areas	Drawing	Figure D.2, Appendix D. Used as landfill separate siting option when combined with LF-4N requiring a storage/curing area for solidified material prior to landfilling
Foundation and Structure Design	Backfill	3 m fill under central operating area. (Ref: GLAL ⁷)
	Earthquake	Design for Zone 1.
Landfill Cell Dimensions		Not applicable.
Landfill Area Restrictions		Not applicable.
Services	Drawing	Figure D.16, Appendix D
	Table	Table 2.5, Chapter 2
Off-Site Drainage	Improvements	None
Off-Site Roads	Improvements	Required (Ref: MMD ¹⁷)
Rail Access	Drawing	Figures D.15, D.16, Appendix D. (Ref: MMD ¹⁶).
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹)
Other		None

TABLE 5.1
CAPITAL COST ESTIMATE - 300 000 t/a CAPACITY
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	CASE 1 - INTEGRATED				CASE 2 - LANDFILL SEPARATE		
SITE	ENGINEERING	CAPITAL COST	LF-9C	LF-3C	LF-1E	LF-4N/PI-1N	LF-4N/PI-13N	LF-1E/PI-27E	
		INCINERATION	56031	56031	56031	56031	56031	56031	
		PHYSICAL/CHEMICAL TREATMENT	46836	46836	46836	46836	46836	46836	
		SOLIDIFICATION	11808	11808	11808	11808	11808	11808	
		ON-SITE FACILITIES	55509	55509	55509	55509	55509	55509	
		ENGINEERED LANDFILL	5866	6065	7215	5368	5368	6997	
		ON-SITE FACILITIES (SITE SPECIFIC)	13664	11278	11177	11959	11493	13731	
		OFF-SITE FACILITIES	2371	2006	3490	2871	4467	3090	
		TOTAL ESTIMATED COST	192085	189533	192066	190382	191512	194002	

NOTE: All costs shown in 1984 thousands of dollars (Canadian)

TABLE 4.5
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE PI-13N

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.18, Appendix D.
	Area	170ha
Site and Lay-out of Process Areas	Drawing	Figure D.2, Appendix D. Used as landfill separate siting option when combined with LF-4N requiring a storage/curing area for solidified material prior to landfilling.
Foundation and Structure Design	Backfill	3 m fill under central operating area. (Ref: GLAL ⁷).
	Earthquake	Design for Zone 1.
Landfill Cell Dimensions		Not applicable.
Landfill Area Restrictions		Not applicable.
Services	Drawing	Figure D.19, Appendix D
	Table	Table 2.5, Chapter 2
Off-Site Drainage	Improvements	None
Off-Site Roads	Improvements	Required. (Ref: MMD ¹⁷)
Rail Access		Not applicable (Ref: MMD ¹⁶)
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹)
Other		None

TABLE 4.6
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE LF-4N

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.14, D.17, Appendix D.
	Area	168 ha
Size and Lay-out of Process Areas	Drawing	Used as landfill separate siting option when combined with PI-1N or PI-13N.
Foundation and Structure Design	Earthquake	Design for Zone 1.
Landfill Cell Dimensions	Height	12 m. See Table 4.8 (Ref: GLAL ⁷)
	Depth	5 m. See Table 4.8 (Ref: GLAL ⁷)
Landfill Area Restrictions	Hydrogeologic	Restricted to site areas where clay depth is greater than 15 m. See Figures D.14, D.17, (Ref: GLAL ⁷ and MMD ¹⁶).
Services	Drawing	Figures D.16 and D.19, Appendix D.
	Table	Table 2.5, Chapter 2
Off-Site Drainage	Improvements	Required. (Ref: GLAL ⁸)
Off-Site Roads	Improvements	Required. (Ref: MMD ¹⁷)
Rail Access		Not applicable
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹).
Other		None

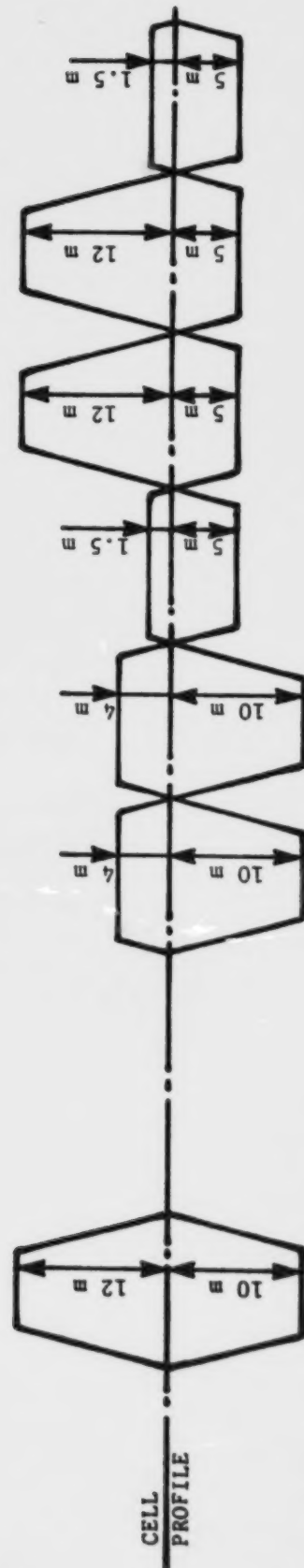
TABLE 4.7
SUMMARY OF ENGINEERING SPECIFIC TO EACH SITE
SITE PI-27E

VARIABLE		COMMENT
Area of Land Parcel	Drawing	Figure D.21, Appendix D.
	Area	188 ha
	Constraint on Layout	See "Other" below.
Size and Lay-out of Process Areas	Drawing Revised	Figure D.2, Appendix D. Used as landfill separate siting option when combined with LF-1E requiring a storage/curing area for solidified material prior to landfilling. Entrance oriented to suit preferred access road and rail access.
Foundation and Structure Design	Piling	Required for all structures (Ref: GLAL ⁷)
	Earthquake	Design for Zone 2.
Landfill Cell Dimensions		Not applicable.
Landfill Area Restrictions		Not applicable.
Services	Drawing	Figure D.22, Appendix D.
	Table	Table 2.5, Chapter 2
Off-Site Drainage	Improvements	None
Off-Site Roads	Improvements	Required. (Ref: MMD ¹⁷)
Rail Access	Drawing	Figures D.21, D.22, Appendix D. (Ref: MMD ¹⁶).
Mitigation		Excavation of archaeological sites required before construction of Facility (Ref: GLAL ⁹)
Other	Utility Corridors	ConRail track and hydro power line diagonally bisect site. Limits choice of positions for central operating area.
	Hydrogeologic	Location of Facility restricted to south and east of ConRail track.(Ref: GLAL ⁷)

TABLE 4.8
LANDFILL CELL PROFILE

CASE 1 INTEGRATED		CASE 2 LANDFILL SEPARATE		
LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-1E/ PI-27E

BASE CASE



CHAPTER 5

CAPITAL AND OPERATING COSTS

5.1 INTRODUCTION

Previous chapters have described the methods used to establish and adjust the engineering design to suit the specific conditions at each siting option. The second major aspect of Monenco's scope of work was to evaluate and rank the siting options in terms of overall cost.

The estimated costs of the Facility were compiled under the two cost components referred to as "Factors", which were used to evaluate the different siting options from an engineering perspective, namely:

- capital cost, and
- operating cost.

These two cost components were further subdivided into various sub-components referred to as "Indicators", to assess how the costs varied between siting options and which costs were common to all siting options.

The various cost items which make up the capital and operating costs are defined on the Factor Sheets in Appendix A.

This methodology is consistent with the site selection team's general approach to comparative evaluation (Ref: OWMC²² and MMD¹⁶).

Capital costs were estimated for both the 150 000 t/a and 300 000 t/a Facility and operating costs were estimated for years 1 through 10 to reflect

the staged buildup of special waste (p. 32) and the expansion of the Facility during the first ten years of operation. These estimates were then used as input into the economic analysis (pp 110 to 117) as part of the comparative evaluation of siting options.

5.2 CAPITAL COST

The capital cost is the total estimated cost to engineer, procure and construct OWMC's Treatment Facility. This phase of the site selection process required a comparison of siting options on the basis of a 300 000 t/a capacity Facility incorporating all identified site specific items for each siting option.

This objective was achieved by using the conceptual engineering work described in the "Status Report - Facility Design" (Ref: MONENCO¹⁹) to define the 150 000 t/a Facility, by estimating additional equipment required to expand the Facility to 300 000 t/a, and by incorporating the engineering features specific to each site.

The total estimated capital cost for each siting option includes an allowance of 15% of the total direct field cost (excluding land costs) for engineering, procurement and construction management, and a further 20% contingency on the total (excluding land costs). The contingency provides for unknown and unforeseen situations which may occur during final design and construction. Excluded from these capital costs estimates are:

- OWMC costs, and
- consultants costs incurred during the five-phase Facilities Development Process.

5.2.1 INDICATORS

The indicators used to allocate the capital costs associated with different areas of the Facility are as follows:

- Costs common to all siting options
 - incineration,
 - physical/chemical treatment,
 - solidification, and
 - on-site facilities.
- Costs specific to each siting option
 - engineered landfill,
 - on-site facilities (site specific), and
 - off-site facilities.

Costs common to all siting options include the key treatment components and general facilities such as drum handling, tank truck unloading etc. which would be located at every siting option.

The **incineration indicator** addresses the incineration plant which includes:

- two rotary kiln incinerators,
- two waste heat recovery boilers,
- two flue gas treatment systems,
- one stack with two flues,
- auxiliary boilers and associated water treatment plant,
- associated buildings, and
- incinerator tank farm.

The **physical/chemical treatment indicator** addresses the physical/chemical treatment plant which includes:

- physical/chemical tank storage,
- inorganic waste treatment system,
- aqueous organic waste treatment system,

- miscellaneous waste treatment system, and
- associated building.

The **solidification indicator** addresses the solidification plant which includes:

- low solids process,
- high solids process,
- storage vessels, and
- associated building.

The **on-site facilities indicator** addresses the general facilities required to complete the central operating area which include:

- site preparation and improvements for the central operating area,
- roads, car park, fencing of the central operating area, drainage, and fire protection system,
- gatehouse and weigh scales,
- administration offices,
- maintenance and workshop building,
- substation and emergency power,
- unloading bay and receiving tanks for bulk liquid waste handling,
- drum storage and handling facility, and
- truck wash.

These areas of the Facility which contribute the common costs are described in the "Status Report - Facility Design" (Ref: MONENCO¹⁹).

Costs specific to each siting option refer to the items addressed in Chapter 4, which had to be established to meet the specific features of each siting option.

The engineered landfill indicator includes:

- initial development of the landfill area of the site including drainage and leachate systems,
- equipment to transport and place the solidified material in the landfill cell,
- associated buildings, and
- construction of the first landfill cell.

The on-site facilities (site specific) indicator addresses other aspects of the general facilities which are specific to a particular siting option and includes:

- fuel oil storage where natural gas is not available at the site,
- sewage treatment for sites not serviced by municipal sanitary sewers,
- additional design requirements to account for the different earthquake zones between the northern sites and the central/eastern sites,
- piling for foundations to suit the geotechnical features of the site,
- additional earth moving, where required, to raise the elevation of the site relative to the subsurface confining layer, to enhance natural containment,
- excavation of archaeological features prior to construction,
- provisions of a cattle crossing on the access road to LF-3C to ease the impact on farm operations,
- additional site roads, fencing and paved areas associated with the facility layout at LF-9C, and
- land acquisition of the sites.

The off-site facilities indicator includes the following services to each site:

- water supply from municipality or other source,
- natural gas supply from local utility,

- electricity supply from local utility,
- telephone supply from Bell Canada,
- sanitary and storm sewer connection to municipal system or other discharge channel,
- drainage improvements to natural drainage channels where required for surface water run-off from each site,
- road upgrading/improvements to the local and regional access roads, and
- land acquisition for additional right-of-way to accommodate road improvements.

Graydon Rogers Appraisals Limited supplied the land acquisition costs included in on-site facilities (site specific), for land parcels identified by M.M. Dillon Ltd. (Ref: MMD¹⁶). These land acquisition costs were then pro-rated to reflect a land parcel which would provide twenty years of landfill life, in order to compare the siting options on an equal basis in the economic analysis.

5.2.2 METHODOLOGY

The capital cost estimate for each siting option was established using data from the following two sources, namely:

- costs estimated in-house from historical data, and
- costs provided by other members of the site selection team and municipalities/utilities.

5.2.2.1 Costs Estimated In-House

Buildings - based on unit costs of floor area using Monenco's in-house data base for the different types and sizes of buildings identified for this project (see Table 2.3 p. 48).

Equipment - based on Monenco's in-house data base for similar types and sizes of equipment, supplemented by pricing obtained from industry wide recognized estimating manuals such as Building and Construction Cost Data 1985, 43rd Annual Edition, published by R.S. Means Company, 1984 and Process Plant Construction Estimating Standards Volume 4, Process Equipment, published by Richardson Engineering Services Inc. 1984. These prices were randomly spot checked for validity against preliminary budget quotations received from suppliers.

Installation (including civil, electrical, instrumentation and piping and materials associated with these) - based on Monenco's in-house data for a similar type and size of Facility expressed as a percentage of the equipment cost.

Site Preparation, roads, utilities - based on unit costs from Monenco's in-house data base with quantities derived from "Layout of Operating Area", "Site Layout" and "Service Connections" Figures in Appendix D.

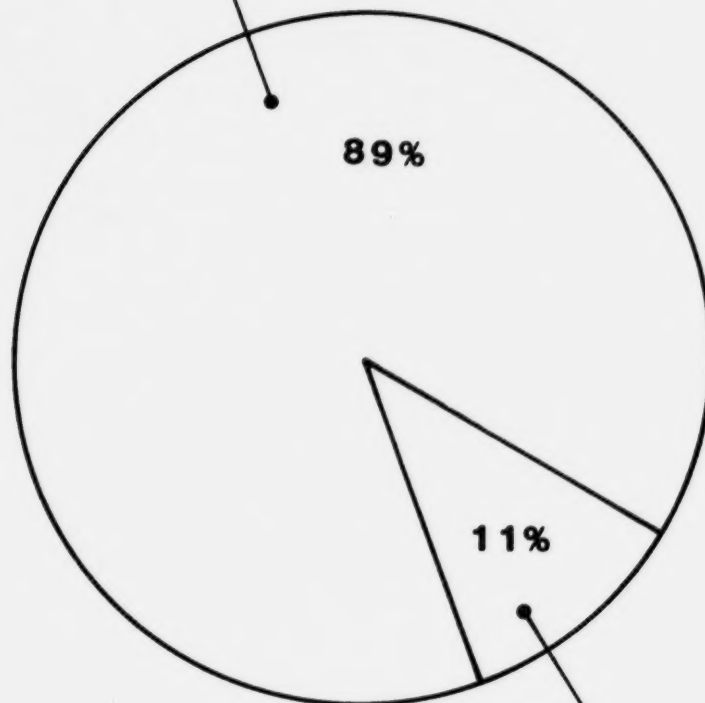
5.2.2.2 Costs Provided by Others

The following costs were provided by other members of the site selection team or by municipalities/utilities:

- Land acquisition - Graydon Rogers Appraisals Limited (Sub-consultant to Leon Kentridge Associates Limited).
- Excavation of archaeological features - Museum of Indian Archaeology (London) (Ref: GLAL⁹).
- Cattle crossing on access road to LF-3C - M.M. Dillon Limited (Ref: MMD¹⁷).
- Road improvements for preferred access roads - M.M. Dillon Limited (Ref: MMD¹⁷).

COSTS COMMON TO ALL SITING OPTIONS

- INCINERATION
- PHYSICAL/CHEMICAL TREATMENT
- SOLIDIFICATION
- ON-SITE FACILITIES



COSTS SPECIFIC TO EACH SITING OPTION

- ENGINEERED LANDFILL
- ON-SITE FACILITIES (SITE SPECIFIC)
- OFF-SITE FACILITIES

NOTE:

FOR DEFINITION OF CAPITAL COSTS,
SEE FACTOR SHEETS IN APPENDIX A

FIGURE 5.1

**DISTRIBUTION OF CAPITAL COSTS
AVERAGE FOR SIX SITING OPTIONS**

5.3 OPERATING COST

The operating cost is the total estimated cost to operate OWMC's Treatment Facility for each year of its planned operating life.

5.3.1 INDICATORS

The indicators used to allocate the costs associated with operation of the Facility are as follows:

- fixed operating costs,
- variable operating costs,
- start-up,
- decommissioning, and
- post closure and long term care.

The **fixed operating cost indicator** includes costs of operating OWMC's Treatment Facility which are independent of the quantity of waste being treated. These are:

- general administration,
- taxes (municipal and business),
- insurance, and
- maintenance.

The **variable operating cost indicator** includes costs of operating OWMC's Treatment Facility which are dependent on the quantity of waste being treated. These are:

- operating labour for the central operating area,
- utilities,
- additives and reagents required for the treatment of special waste and for services on-site,

- engineered landfill including placement of solidified material, monitoring ground water and leachate quality, and construction of two landfill cells each year, and
- transportation of special waste from the waste generators to site, intersite transfers between partially integrated sites and additives and reagents from the suppliers to site.

The **start-up indicator** covers the costs during start-up of OWMC's Treatment Facility, including:

- hiring and training of staff, initial marketing and advertising prior to commercial operation of the Facility,
- an allowance to cover the initial operational adjustments during start-up of the 150 000 t/a Facility, and
- an allowance to cover the initial operational adjustments during start-up of the expansion of the Facility to 300 000 t/a.

The **decommissioning indicator** covers the cost associated with closing the Facility at the end of its useful life, including decontamination and disposal of all equipment, structures, surfaces and contaminated soil, before restoring the land associated with the central operating area to its pre-facility condition.

The **post closure and long term care indicator** covers the annual costs to be incurred after closure of the engineered landfill which include:

- on-going monitoring, including surface and ground water monitoring, and
- on-going maintenance of landfill cover, leachate collection system and surface drainage system.

5.3.2 METHODOLOGY

The operating cost for each siting option estimate was established using data from the following two sources, namely:

- costs estimated in-house, and
- costs provided by other members of the site selection team and municipalities/utilities.

5.3.2.1 Costs Estimated In-House

Fixed Operating Costs - based on Monenco's in-house historical data, general administration, taxes and insurance were assessed at 4% of total capital costs and maintenance was assessed at 3% of total capital costs excluding landfill and land acquisition costs.

Operating Labour - an average annual labour cost was developed from Statistics Canada's March 1984 Catalogue 72-002 Employment Earnings and Hours, including an allowance for fringe benefits of 11%, and applied to the labour force identified in Appendix C.3.

Additives and Reagents - prices FOB suppliers plants for the additives and reagents identified in Table 2.2 (p. 47) were extracted from Corpus Chemical Report July 1984, published by Corpus Information Services Ltd, Don Mills, or based on quotations from major suppliers.

Engineered Landfill - based on M.M. Dillon Limited in-house data for similar types and sizes of landfills.

Start-Up, Decommissioning, Post Closure and Long Term Care - estimated in-house based on similar types and sizes of Facilities.

5.3.2.2 Costs Provided by Others

The following costs were provided by other members of the site selection team or municipalities/utilities:

- Electricity - Electricity rates were supplied by Ontario Hydro and local authorities.
- Water/Sewer - Water supply and sewer surcharges were supplied by Local Municipalities.
- Fuel - Natural gas rates were supplied by Provincial Gas and Union Gas. Fuel oil prices were obtained from local suppliers.
- Transportation - Trucking of special wastes, additives and reagents, and intersite transfers were supplied by M.M. Dillon Limited (Ref: MMD¹⁷).

5.3.3 ANNUAL OPERATING COSTS

The fixed and variable operating costs were estimated in two stages. The first stage considered the initial Facility operating at full capacity (150 000 t/a) in year 5 of operation. The second stage considered the expanded Facility operating at full capacity (300 000 t/a) in year 10 of operation. The annual operating costs for years 1 through 4 and 6 through 9 were then established by prorating the variable operating costs in accordance with the build up of special waste being treated, as identified in Section 2.2.3.3 (p. 32). Annual operating costs for years 11 through 20 (the remaining life of the Facility for comparative evaluation purposes in Phase 4A) will remain constant at the value estimated for year 10, when the Facility has built up to its full capacity of 300 000 t/a.

5.3.4 PRESENTATION OF ESTIMATES

The annual operating costs of OWMC's Treatment Facility at the six siting options are presented in Table 5.2. It will be noted that the difference between the highest cost siting option (LF-1E/PI-27E) and the lowest cost

siting option (LF-4N/PI-1N) varies up to 10% depending on the year of operation.

The distribution of operating costs is illustrated in Figure 5.2, which illustrates the average costs for the six siting options.

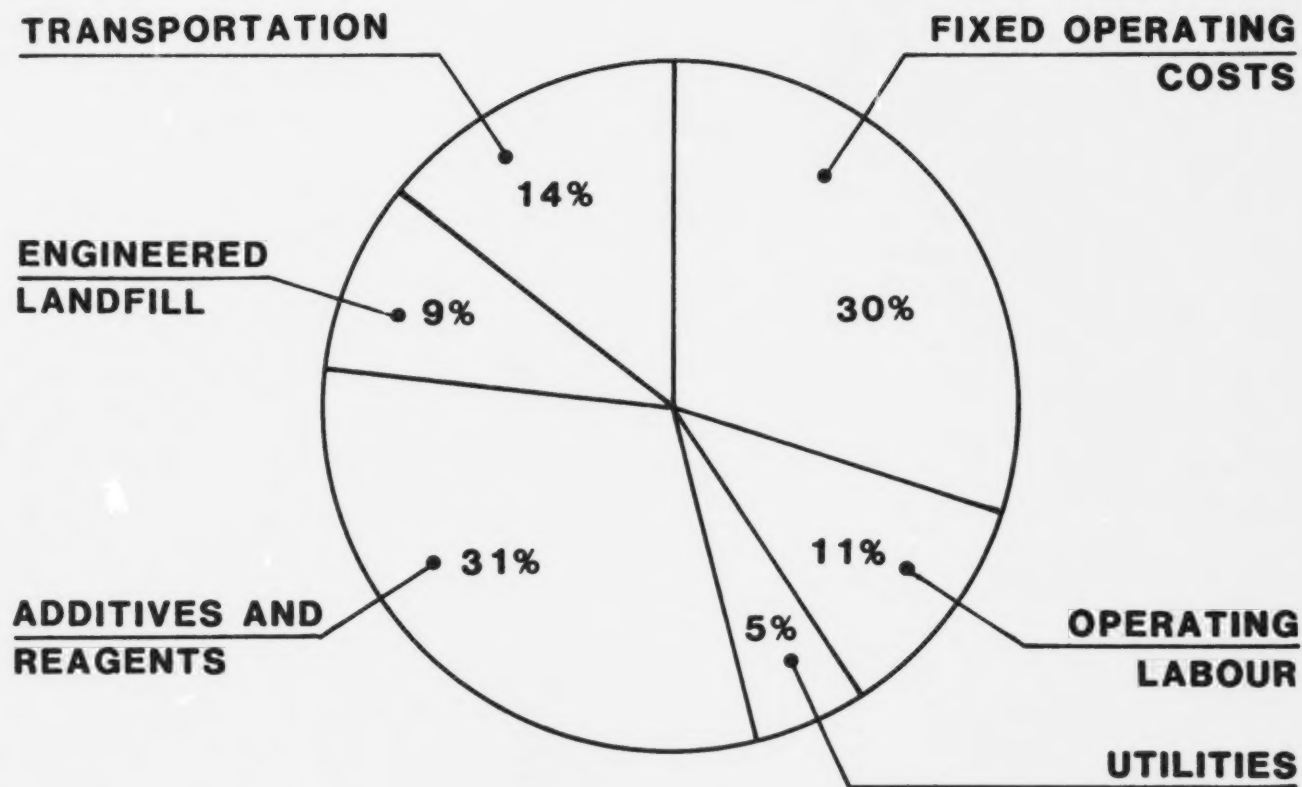
Summary tables in Appendix E present the operating costs for year 5 (Table E.3), year 10 (Table E.4), start-up, decommissioning and post closure (Table E.5) and the summary of annual costs (Table E.6). The year 10 operating costs for Case 2 and Case 3 were used as an input to the selection of a preferred location of the physical/chemical treatment plant as described in Chapter 3 (pp 56 to 60, 67).

TABLE 5.2

ANNUAL OPERATING COSTS
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	ENGINEERING	OPERATING COST SUMMARY	YEAR -1	3600	3600	3600	3600	3600	3600
			1	20479	20429	20191	20265	20397	20585
			2	18851	18773	19827	18291	18409	20107
			3	22105	22083	23179	21580	21711	23505
			4	24137	24156	25283	23707	23847	25713
			5	25957	26008	27158	25607	25774	27596
			6	34726	34903	36064	34385	34582	36705
			7	35174	35356	37791	34741	34937	38544
			8	37411	37641	40106	37130	37341	41033
			9	40153	40434	42928	39848	40074	43851
			10 - 20	42500	42828	45354	42295	42536	46398
			21	14900	14900	14900	14900	14900	14900
			22	200	200	200	200	200	200

NOTE: All costs shown in 1984 thousands of dollars (Canadian)



NOTE:

**FOR DEFINITION OF OPERATING COSTS,
SEE FACTOR SHEETS IN APPENDIX A**

FIGURE 5.2
DISTRIBUTION OF OPERATING COSTS
AVERAGE FOR SIX SITING OPTIONS

CHAPTER 6
COMPARATIVE EVALUATION OF SITING OPTIONS

6.1 INTRODUCTION

The preceding chapters have described the characteristics of the proposed Facility, the site specific engineering associated with locating the Facility at each of the siting options and the estimated costs involved.

This chapter commences with a discussion of landfill life including a statement of assumptions used for the site selection process in Phase 4A and an outline of alternatives still under consideration. Although landfill life is an important aspect of site selection, it is greatly influenced by the type of landfill selected and specific details of design. These matters can only be determined following completion of a site specific geoscience program. Landfill life is also influenced by the quantity of solidified material requiring disposal and this could vary quite substantially depending upon the effluent disposal option ultimately selected.

Following the landfill life discussion, an economic analysis is presented which compares the siting options on a common basis. This analysis establishes the merits of one siting option relative to the others in terms of cost, and is not intended to indicate the overall economics of the proposed Facility.

The comparative cost evaluation is then tested for sensitivity to variation in economic assumptions, the use of rail for the transportation of additives and reagents, and reduction in land parcel size for sites LF-3C and LF-1E. The effect on siting option ranking of disposing of treated effluent

by evaporation, rather than by solidification, is also noted. This method of effluent disposal is more fully discussed in Chapter 7.

One further aspect of the sensitivity testing included an analysis of engineering flexibility to determine if the design development of the Facility (which is proceeding in parallel with and beyond Phase 4A site selection) would be significantly constrained by the selection of any siting option.

6.2 LANDFILL LIFE

A number of assumptions were made for Phase 4A in respect of the landfill design and layout of the landfill area which have a major influence on the landfill life estimates. The assumptions involved the following:

- Landfill type and design.
- Effluent disposal option and quantities of solidified material produced.
- Size and orientation of central operating area and access corridors.
- Approach to surface drainage control.

The following discussion identifies how deviations from the assumptions established for Phase 4A could affect landfill life estimates at the various siting options.

6.2.1 LANDFILL TYPE AND DESIGN

The "Status Report - Facility Design" (Ref: MONENCO¹⁹), contains a general discussion of the design features of three types of engineered landfill which have been identified for more detailed study, namely:

- conventional landfill,
- above-ground landfill, and
- shallow entombed landfill.

For the purposes of Phase 4A, OWMC identified the conventional landfill type, which provides the greatest landfill capacity for a given site area, as the basis for the comparative evaluation of siting options.

During Phase 4B of the Facilities Development Process, site specific studies and development of design concepts will be carried out for the preferred site(s).

A multi-disciplinary evaluation of the landfill types and design components will be undertaken based on site specific hydrogeologic and geotechnical conditions which will be studied during the Phase 4B site investigations (Ref: OWMC23) and various engineering considerations. Engineering input will be provided on relative land area requirements and site capacity, as well as design, construction, operation, maintenance, long term care, and cost aspects of the different landfill types and design components.

Computer modelling, based on conditions at the preferred site(s) will be carried out to assess the performance of the different landfill types and design components.

At the completion of the evaluation process, a recommendation will be made to OWMC on the preferred landfill type and on the design of specific components. This will establish the basis for developing the landfill conceptual design for the preferred site(s).

The type of landfill that is finally selected (i.e. conventional, shallow entombed, or above-ground) could have a major impact on landfill life. However, landfill life is just one of many environmental and engineering factors to consider in selecting the type of landfill best suited for OWMC's Facility.

Some of the specific design aspects which can additionally influence landfill life are briefly discussed as follows:

Side Slopes

All landfill life estimates for Phase 4A have been based on the assumption of 3:1 side slopes, both above and below ground. For the below ground slopes, this is a conservative figure which allows for the placement of a flexible membrane liner, if required, and also allows for the lack of data on geotechnical conditions. More detailed site investigations may identify that steeper side slopes can be achieved and this could significantly increase landfill life.

Because of drainage and erosion control considerations, it is unlikely that above-ground slopes could be significantly greater than 3:1.

Discrete Cell vs Continuous Trench vs Area Type of Operation

All landfill lives to date have been based on the use of discrete cells, uniformly sized for a six month capacity based on estimated solidified material volumes at year 10. The cell width was assumed to be 100 m in all cases to allow for the option of using a temporary air supported cover over the open operating cell. Some improvements in landfill life could result from increasing the width and/or length of cells or area development of the landfill and these possibilities will be fully evaluated in Phase 4B.

Depth and Height of Solidified Material

For Phase 4A, uniform cross-sectional cell configurations were assumed, and these were modified where appropriate on the basis of available hydrogeologic and/or geotechnical constraints (site-adapted designs) as detailed in Chapter 4 (pp 74, 75, 86). The site specific studies in Phase 4B may confirm the assumed configurations or require that the assumed height and/or depth of fill be reduced or increased with a corresponding effect on landfill life. It is also possible that the cross-sectional configurations may be varied in different areas of the site if it is found that soil and ground water conditions vary across the site.

Optimizing Cell (or Trench) Size and Layout to Site Layout

It is unlikely that any site layout will neatly accommodate a specific number of uniformly sized rectangular cells or trenches. Hence not all cells (or trenches) will actually be of the uniform size and shape previously assumed. The layout of the landfill can be optimized once all areas of land available for landfill development are known.

Cover and Liner System Thickness

For Phase 4A, all landfill configurations were assumed to have a liner and cover system, each 1 m in thickness. If the Phase 4B site investigation and design activities show these thicknesses must be changed, then this may affect landfill life.

6.2.2 EFFLUENT DISPOSAL OPTION AND QUANTITIES OF SOLIDIFIED MATERIAL PRODUCED

OWMC are currently considering a number of options for the ultimate disposal of treated effluent from the physical/chemical treatment plant (Ref: OWMC²³). These options are:

- Evaporation with discharge to the atmosphere (**partial solidification with evaporation**).
- Treatment in the solidification plant and disposal in an engineered landfill (**total solidification**).
- Discharge via pipeline to a receiving water body or sewer system.
- Trucking to a receiving water body or sewer system.
- Deep well injection.

For the purpose of the Phase 4A comparative evaluation of siting options, two options for effluent disposal were considered (Ref: MMD¹⁶):

- total solidification, and
- partial solidification with evaporation.

Chapters 1 through 6 of this report address the total solidification option, while Chapter 7 assesses the effects of using partial solidification with evaporation. The final choice of effluent disposal option has a significant impact on the landfill life. Partial solidification with evaporation results in a much longer landfill life due to the reduced quantity of solidified material requiring landfill disposal as shown on Tables 6.1 (p. 111) and 7.5 (p. 147).

In addition to the effluent disposal option selected, the quantity of solidified material going to the landfill is affected by:

- solids content of the special waste,
- quantity of landfill leachate requiring treatment, and
- ability to reuse treated effluent on-site.

The assumptions that have been used to determine the quantity of solidified material for landfilling are identified in Chapter 2 (p. 25). In all cases, conservative assumptions have been made. The use of treated effluent on site has considerable potential to reduce quantities being solidified and hence increase landfill life, for the total solidification option.

6.2.3 SIZE AND ORIENTATION OF CENTRAL OPERATING AREA AND ACCESS CORRIDORS

The "Layout of Operating Area" and "Site Layout" Figures in Appendix D were developed for Phase 4A, as discussed in Chapter 4 (pp 71 to 73, 75, 76), to establish the area available for landfilling at each landfill site. The available area for landfilling, and hence landfill life, may change following engineering studies to optimise the layout of the central operating area.

6.2.4 APPROACH TO SURFACE DRAINAGE CONTROL

The current landfill design concept includes surface water detention ponds to control the rate of uncontaminated surface water runoff from the landfill site. If a decision were taken that full retention of all surface runoff is required to permit detailed analysis prior to discharge, then a larger area for holding ponds would be required, which would in turn reduce the area available for landfilling and hence landfill life (or deeper ponds with pumped discharge may be used).

6.2.5 LANDFILL LIFE ASSESSMENT

The estimated landfill life for each siting option is presented in Table 6.1, based on the assumptions established for Phase 4A as described herein. The assumptions are considered to form a realistic basis for the comparative assessment of siting options.

6.3 ECONOMIC ANALYSIS

An economic analysis was conducted to enable the siting options to be compared on the basis of cost.

6.3.1 ECONOMIC PARAMETERS AND INPUTS

The analysis has been carried out in terms of nominal dollars (i.e. in dollars of the year of expenditure) which are discounted to provide their cumulative present worth as of 1984 (mid-year). The first year of operation is assumed to be 1991 with a staged buildup to 150 000 t/a in 1995 and to 300 000 t/a in 2000, as shown on Figure 6.1.

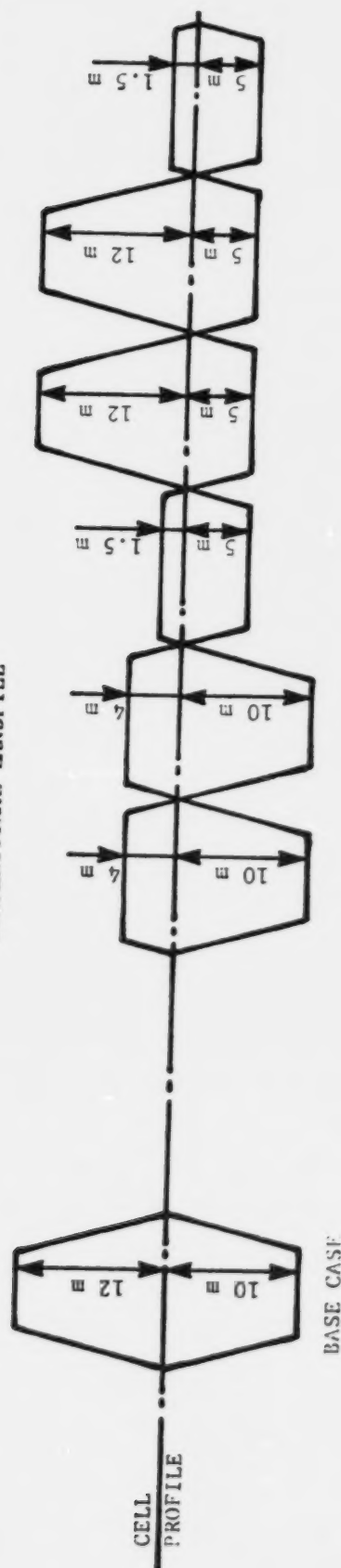
TABLE 6.1

LANDFILL CELL PROFILE

TOTAL SOLIDIFICATION

300 000 t/a CAPACITY

CONVENTIONAL LANDFILL



STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	CASE 1 INTEGRATED			CASE 2 LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	ENGINEERING	SITE AREA	LANDFILL LIFE (YEARS) TOTAL SOLIDIFICATION	14	19	12	15.5	15.5	11

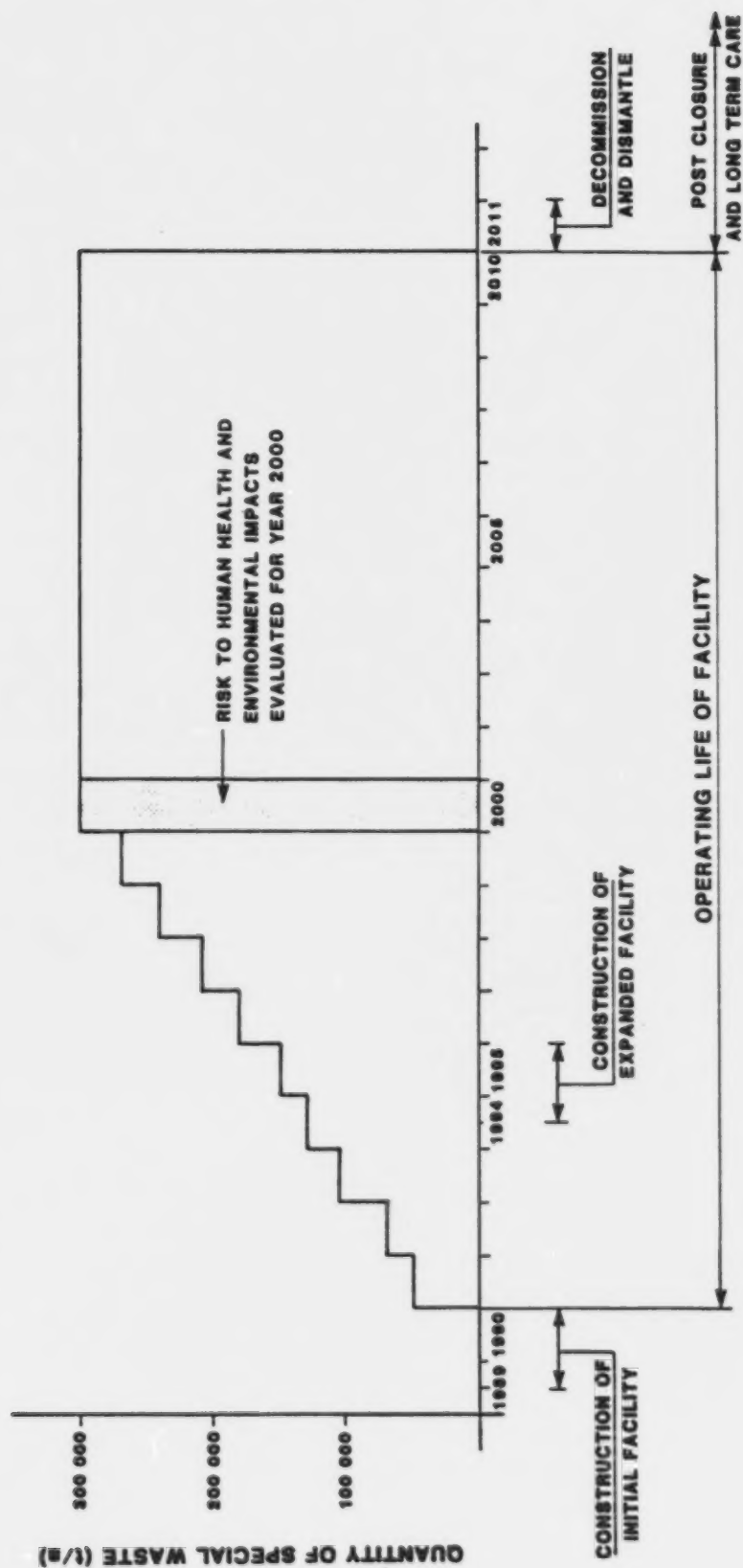
The escalation (inflation) and discount (cost of capital or interest) rates used in the analysis reflect long term rates which were being forecast early in 1985, when the initial economic analysis was carried out. Since the rates are regarded as indicative of long term inflation and interest levels, the values have not been changed over the period studied. The individual values chosen for escalation rate (7%) and for discount or cost of capital rate (11%) result in an effective or real discount rate (i.e. inflation-free) of 3.7%, which is judged to be appropriate for this analysis.

The period of time over which the annual costs are calculated and accumulated for the purpose of this comparative evaluation is shown on Figure 6.1. This economic life, in turn, is dependent upon the service lives of the major processing units or operating components. In this analysis the landfill design life is the governing component, with all sites required to provide at least twenty years of landfill capacity under the assumption of total solidification. The previous Section 6.2 (pp 105 to 110) discussed the landfill life estimated for each siting option and presented in Table 6.1 (p. 111), which showed that when operating under the mode of total solidification, none of the siting options achieved 20 years, ranging from 11 years at LF-1E/PI-27E to 19 years at LF-3C. In order to compare siting options on an equal basis, additional land requirements to achieve 20 years were estimated for each siting option, and the additional costs for the extra land pro-rated from the land acquisition costs provided by Graydon Rogers Appraisals Limited, as described in Chapter 5 (p. 92). Thus the costs of the alternative siting options have been developed for the twenty year period and the comparison ranking made on this basis.

It is possible, however, that the Facility will be operated beyond this twenty year period since the processing units are expected to have service lives greater than twenty years and the landfill capacity constraints could be expected to be resolved. The analysis does consider, during the sensitivity testing, an extended operating period for the purpose of amortizing the capital investment. Beyond that case, all analyses are carried out assuming a twenty year study period.

FIGURE 6.1

LIFE CYCLE OF FACILITY FOR ECONOMIC ANALYSIS



At the end of the operating period there are certain expenditures required to decommission the Facility and provide for ongoing monitoring of the site after decommissioning. Provision has been made in the annual cost analysis for the one time cost of decommissioning in year 21. In addition, the capital required to provide a perpetual annuity in the amount required for long term monitoring has been included in the year 20 costs.

The economic inputs and assumptions are summarized in Table 6.2.

TABLE 6.2

MAJOR INPUTS AND ASSUMPTIONS
TO THE ECONOMIC ANALYSIS

Cost of Capital	11%
Escalation Rate ¹	7%
Economic Life of Facility	20 years
Capital Expenditure Pattern	150 000 tonnes 40% 1989 60% 1990
	300 000 tonnes 40% 1994 60% 1995
Salvage Value	no value
Decommissioning	lump sum in year 21
Long Term Care	beginning in year 21
Working Capital	1-1/2 months of year 1 operating costs, increasing to 1 1/2 months of year 5 operating costs upon expansion.
Interim Replacement ²	1% of capitalized cost of Facility, per annum.

NOTES:

1. The escalation rate is applied to both capital and operating costs.
2. This allows for replacement of equipment with less than a 20 year service life.

6.3.2 CAPITAL COSTS

Capital cost estimates for the Facility under the various siting options, presented in Chapter 5 (p. 95), were utilized in the economic analysis in the following manner.

The initial expenditures required for the 150 000 t/a Facility were assumed to be 40% two years before operation and 60% one year before operation. Interest during construction was calculated at 11% per annum on the average outstanding balance until facility commissioning, the beginning of year one. The expenditures required to expand the Facility to increase throughput to 300 000 t/a were assumed to be spent in operation years four (40%) and five (60%) respectively. Again interest was calculated on the outstanding balance and added to the capitalized value of the Facility. In all cases the cost estimates were escalated to the year of expenditure using the assumed rate of 7% per annum.

Allowances for initial working capital requirements and start up costs were added to the capitalized facility value in the year before commissioning for the initial 150 000 t/a Facility and year 5 for the expanded 300 000 t/a Facility. Working capital was calculated as 1 1/2 months of the following year's operating costs.

Provision was also made for replacing components of the Facility during the twenty year period of analysis.⁴ These interim replacements were included in the annual costs as 1% of the capitalized value of the Facility.

6.3.3 OPERATING COSTS

The annual costs for operation and maintenance of the Facility were based on a gradual build up in throughput from 50 000 t/a in year 1 to 300 000 t/a in year 10. Beyond year 10 the basic operating costs are assumed to remain constant in real terms, subject only to the annual escalation rate of 7%. These operating costs terminate in year 20, which also includes the capital requirement for the annuity providing funds for long term care. Year 21 is charged with the full cost of decommissioning the Facility.

6.3.4 COST COMPARISON METHODOLOGY

The economic inputs, assumptions and cost estimates were all combined in a lifecycle costing model which converted all project costs into annual costs, ensuring that all capital charges were amortized over the facility operating period. The present value of these streams of annual costs were then calculated, taking into account the time value of money. The resulting cumulative amount, stated in 1984 dollars, represents the equivalent amount required to exactly offset the total capital and operating costs over the operating period. Since all siting options are designed to provide the same throughput capabilities or "benefits", over the operating period, the cumulative present value of annual costs can be used to compare the relative economics of the siting options. It should be noted that the various options contain virtually identical process facilities and thus a large proportion (89%) of the capital costs are common to each siting option. This tends to make percentage or ratio comparisons between siting options appear relatively small.

6.3.5 ANALYSIS OF RESULTS

For each of the siting options the basic inputs and assumptions were applied to the capital and operating costs to arrive at a present value of lifecycle annual costs. This permitted a "base case" ranking of the results and this initial ranking, along with the cumulative present worth figures, is presented in Table 6.3. It is evident that the effect of having a large proportion of the capital and operating costs common to all the siting options tends to overshadow the differences in land acquisition costs, road improvements and other site specific items. However, if the cost differentials are taken as absolute amounts, it can be seen that significant amounts are involved. For example the difference between the highest and lowest ranked siting options is approximately \$40 million.

TABLE 6.3
OVERALL RANKING OF COSTS
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
		LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	COST (Present Value of Lifecycle Annual Costs)	572	572	595	567	570	606
OPTION RANKING		3	3	4	1	2	5

NOTE: All costs shown in 1984 million dollars (Canadian).

6.4 SENSITIVITY ANALYSIS

As part of the comparative evaluation of siting options, sensitivity analyses were required to test the assumptions used to establish the ranking of siting options (Ref: MMD16). From an engineering perspective, this involved determining the effects of the following:

- Changing the economic inputs and assumptions used in the economic analysis.
- Transporting additives and reagents to site by rail.
- Changes to the site size at candidate sites LF-3C and LF-1E.
- Use of partial solidification with evaporation as the means of effluent disposal, rather than total solidification.
- An analysis of engineering flexibility to determine if the design development of the Facility, including various options being considered by OWMC, would be significantly constrained by the selection of any siting option.

6.4.1 ECONOMIC ANALYSIS

In addition to the basic economic analysis described in Section 6.3, the impact of possible variations in several of the key inputs was examined. These included changes to:

- capital cost estimates,
- operating cost estimates,
- cost of capital,
- escalation rates,
- economic service life of the Facility, and
- maximum capacity of the Facility.

In each case, only the variable stated was changed and all other inputs remained at the basic values.

Capital cost estimates were varied plus 30% and minus 18% in accordance with the assumed level of accuracy for the preliminary cost estimates and resulted in minimal differences to the ranking of siting options.

Operating cost estimates were varied plus 30% and minus 18% in accordance with the assumed level of accuracy for the preliminary cost estimates and resulted in minimal differences to the ranking of siting options.

Cost of capital was varied plus 2% and minus 2% with no difference to the ranking of siting options. It should be explained, however, that by keeping the escalation rate constant and varying the cost of capital, then the effective or real discount rate (i.e. inflation-free) is significantly different in absolute terms.

Using an escalation rate of 7% and a cost of capital rate of 13%, the real discount rate (i.e. inflation free) becomes 2.3% resulting in a present value of lifecycle annual costs in 1984 dollars ranging from \$447 million to \$476 million.

Using an escalation rate of 7% and a cost of capital rate of 9%, the real discount rate (i.e. inflation free) becomes 6.1% resulting in a present value of lifecycle annual costs in 1984 dollars ranging from \$737 million to \$789 million.

Escalation rates were varied plus 2% and minus 2% with minimal differences to the ranking of siting options.

Economic service life of the Facility was varied from 20 years to 30 years with minimal differences to the ranking of siting options.

150 000 t/a capacity Facility with no expansion during its 20 years service life resulted in minimal differences to the ranking of siting options.

The results are presented in Table 6.4.

TABLE 6.4

**OVERALL RANKING OF COSTS
SENSITIVITY TESTING
TOTAL SOLIDIFICATION**

VARIATION	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
	LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
CAPITAL COST +30%	623	622	646	618	621	657
RANKING	4	3	5	1	2	6
CAPITAL COST -18%	541	541	565	537	540	575
RANKING	3	3	4	1	2	5
OPERATING COST +30%	689	690	720	684	688	733
RANKING	3	4	5	1	2	6
OPERATING COST -18%	501	501	520	497	500	530
RANKING	3	3	4	1	2	5
COST OF CAPITAL +2% (i.e. 13%)	450	450	468	447	449	476
RANKING	3	3	4	1	2	5
COST OF CAPITAL -2% (i.e. 9%)	743	743	775	737	741	789
RANKING	3	3	4	1	2	5
ESCALATION RATE +2% (i.e. 9%)	746	747	779	740	745	793
RANKING	3	4	5	1	2	6
ESCALATION RATE -2% (i.e. 5%)	444	444	461	441	443	469
RANKING	3	3	4	1	2	5
30 YEAR LIFE CYCLE	702	702	734	696	700	748
RANKING	3	3	4	1	2	5
150 000 t/a CAPACITY 20 YR. LIFE CYCLE	419	417	431	415	418	438
RANKING	4	3	5	1	2	6

NOTE: Costs are present value of life cycle annual costs in 1984 million dollars (Canadian).

6.4.2 TRANSPORTATION OF ADDITIVES AND REAGENTS BY RAIL

Further to the selection of preferred rail access discussed in Chapter 3 (pp 55, 56), the site selection team was required to address the effect on the ranking of siting options should the opportunity to use rail access for bulk shipments of additives and reagents be included in the facility design and operation (Ref: MMD¹⁶). As discussed in Chapters 3 (p. 55) and 4 (p. 78), the analysis of rail options indicates that only five of the six siting options can be served by a suitable rail option. Rail service to candidate site PI-13N is not deemed feasible due to severe environmental impacts and high cost considerations (Ref: MMD¹⁶). The operating area layouts and site layouts take account of rail access where rail access is feasible, so the only engineering concern for ranking of siting options was if the inclusion of rail significantly affected cost.

The capital cost for the preferred rail access, including the necessary land acquisition, has been estimated by M.M. Dillon Limited (Ref: MMD¹⁷) and ranges from \$340 000 at LF-1E/PI-27E to \$2 140 000 at LF-9C.

The difference in transportation costs for rail haulage was not established for Phase 4A, but the preliminary indication by M.M. Dillon Limited (OWMC's transportation consultant), is that transportation costs for rail will be similar to that of road haulage (Ref: MMD¹⁷).

The economic analysis detailed in Section 6.3 and the sensitivity testing of the economic analysis detailed in Section 6.4.1 would indicate that, when amortized over the 20 year life of the Facility, the difference in capital costs for rail access will be negligible, and hence the transportation of additives and reagents by rail would not change the ranking based on cost considerations.

6.4.3 PARCEL SIZES FOR LF-3C, LF-1E

During the detailed comparative evaluation, the site selection team was required to address the effect on ranking of siting options of reducing the size of candidate sites LF-3C and LF-1E.

The factor "Site Area" and the indicators "Site Size" and "Landfill Life", were applied to the parcel options identified by M.M. Dillon Limited (Ref: MMD16) to confirm that the parcels being analyzed by the site selection team were of adequate size to accommodate the Facility, including the technical buffer zone, and to estimate the landfill life available.

The results are summarized on Tables 6.5 and 6.6, which illustrate that although the Facility, including technical buffer zone, can be accommodated on a smaller parcel size, the landfill life would decrease. The impact of reduced land parcel on landfill life is most pronounced at LF-3C.

6.4.4 PARTIAL SOLIDIFICATION WITH EVAPORATION

During Phase 4A, methods other than total solidification for the disposal of liquid effluent were identified (Ref: OWMC²³).

The alternative options for the ultimate disposal of liquid effluent from the physical/chemical treatment plant are:

- evaporation with discharge of water vapour to the atmosphere,
- treatment in the solidification plant and disposal in an engineered landfill,
- discharge via pipeline to a receiving water body (Lake Ontario or Lake Erie) or sewer system,
- trucking to a receiving water body or sewer system, and
- deep well injection.

TABLE 6.5
SENSITIVITY ANALYSIS
CHANGES TO PARCEL SIZE
LF-3C (INTEGRATED SITING OPTION)

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	OPTIONS	
				1*	2
SITE	ENGINEERING	SITE AREA	SITE SIZE	ADEQUATE FOR FACILITY PLUS BUFFER ZONE	ADEQUATE FOR FACILITY PLUS BUFFER ZONE
			LANDFILL LIFE TOTAL SOLIDIFICATION	19 YEARS	14 YEARS

NOTE: *Parcel option used for Phase 4A comparative evaluation (Ref: MMD¹⁶).

OPTION DEFINITION

- Option 1 - Entire Site (Ref: MMD¹⁶).
- Option 2 - Entire Site excluding parcel east of Krick Road (Ref: MMD¹⁶).

RATIONALE

- Both options can accommodate the Facility plus the technical buffer zone.
- Option 1 has longer landfill life.

TABLE 6.6
SENSITIVITY ANALYSIS
CHANGES TO PARCEL SIZE
LF-1E (INTEGRATED SITING OPTION)

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	OPTIONS		
				1*	2	3 **
SITE	ENGINEERING	SITE AREA	SITE SIZE	ADEQUATE FOR FACILITY PLUS BUFFER ZONE	ADEQUATE FOR FACILITY PLUS BUFFER ZONE	ADEQUATE FOR FACILITY PLUS BUFFER ZONE
			LANDFILL LIFE TOTAL SOLIDIFICATION	12 YEARS	11-1/2 YEARS	9-1/2 YEARS

NOTES: * Parcel option used for Phase 4A comparative evaluation integrated siting option (Ref: MMD¹⁶).

** Parcel option used for Phase 4A comparative evaluation partially integrated siting option (Ref: MMD¹⁶).

OPTIONS DEFINITION

- Option 1 - Entire Site (Ref: MMD¹⁶).
- Option 2 - North half of Site plus parcel South of Young Road plus parcel South of Young Road and West of Morris Road (Ref: MMD¹⁶).
- Option 3 - North half of Site plus parcel South of Young Road (Ref: MMD¹⁶).

RATIONALE

- All options can accommodate the Facility plus the technical buffer zone.
- Option 1 has longer landfill life.

These methods are still under consideration by OWMC and have the following advantages:

- increase in landfill life,
- reduction in solidification reagents required,
- reduction in transportation requirements for trucking solidified material to the landfill site for a separate landfill siting option, and
- reduced operating cost.

OWMC required the site selection team to conduct an overview of these effluent disposal options in order to ascertain whether the selection of any option would be constrained by the selection of any siting option. The overview analysis determined that none of the siting options under consideration would constrain the selection of any effluent disposal options (Ref: MMD16).

Given this situation, the site selection team were directed to include the effluent disposal option, "Partial Solidification with Evaporation" (where treated effluent is evaporated and discharged to atmosphere via a stack, while residues are solidified prior to disposal in the engineered landfill) to determine whether the selection of this alternative, rather than total solidification, would affect the ranking of siting options resulting from their comparative evaluation.

Facility characteristics information was developed for other members of the site selection team to assess the effect of partial solidification with evaporation on the ranking of siting options. This is documented in Chapter 7 (pp 138 to 141) together with the results of a comparative assessment of siting options for the partial solidification scenario, from an engineering perspective.

6.4.5 ENGINEERING FLEXIBILITY

Engineering flexibility was introduced as part of the sensitivity analysis, performed after the comparative evaluation, to determine if the design development of the Facility (which is proceeding in parallel with and beyond Phase 4A site selection) would be significantly constrained by the selection of any siting option.

Although the constraints identified by other members of the site selection team, as discussed in Chapter 4 (pp 70 to 86), were incorporated into the engineering specific to each site, and hence reflected in the cost estimates presented in Chapter 5 (pp 90 to 92), there may be other constraining features which could significantly impact on the various options being considered by OWMC at the present time and the freedom of the engineer (Monenco Limited) to produce the optimal design. This factor was introduced to address this matter.

The engineering flexibility factor is basically concerned with two aspects of the design development:

- facility design, and
- facility layout.

These two indicators were further subdivided into sub-indicators as defined on the Factor Sheets in Appendix A.

6.4.5.1 Facility Design

Two aspects of the facility design have to be addressed by OWMC's consultants and adopted by OWMC as part of the design development, namely:

- landfill design, and
- effluent disposal option.

Landfill Design

As discussed in Section 6.2.1 (p. 105) OWMC have identified three general types of engineered landfill (Ref: MONENCO¹⁹, OWMC²³) for the disposal of treated and solidified waste residues, namely:

- conventional,
- above-ground, and
- shallow entombed.

For the purposes of the Phase 4A site selection process, OWMC identified the conventional type for use as the basis for the comparative evaluation of siting options.

During Phase 4B of the Facilities Development Process, site specific studies will be carried out for the preferred site(s), leading to the selection of a preferred landfill concept based on a number of factors (p 98).

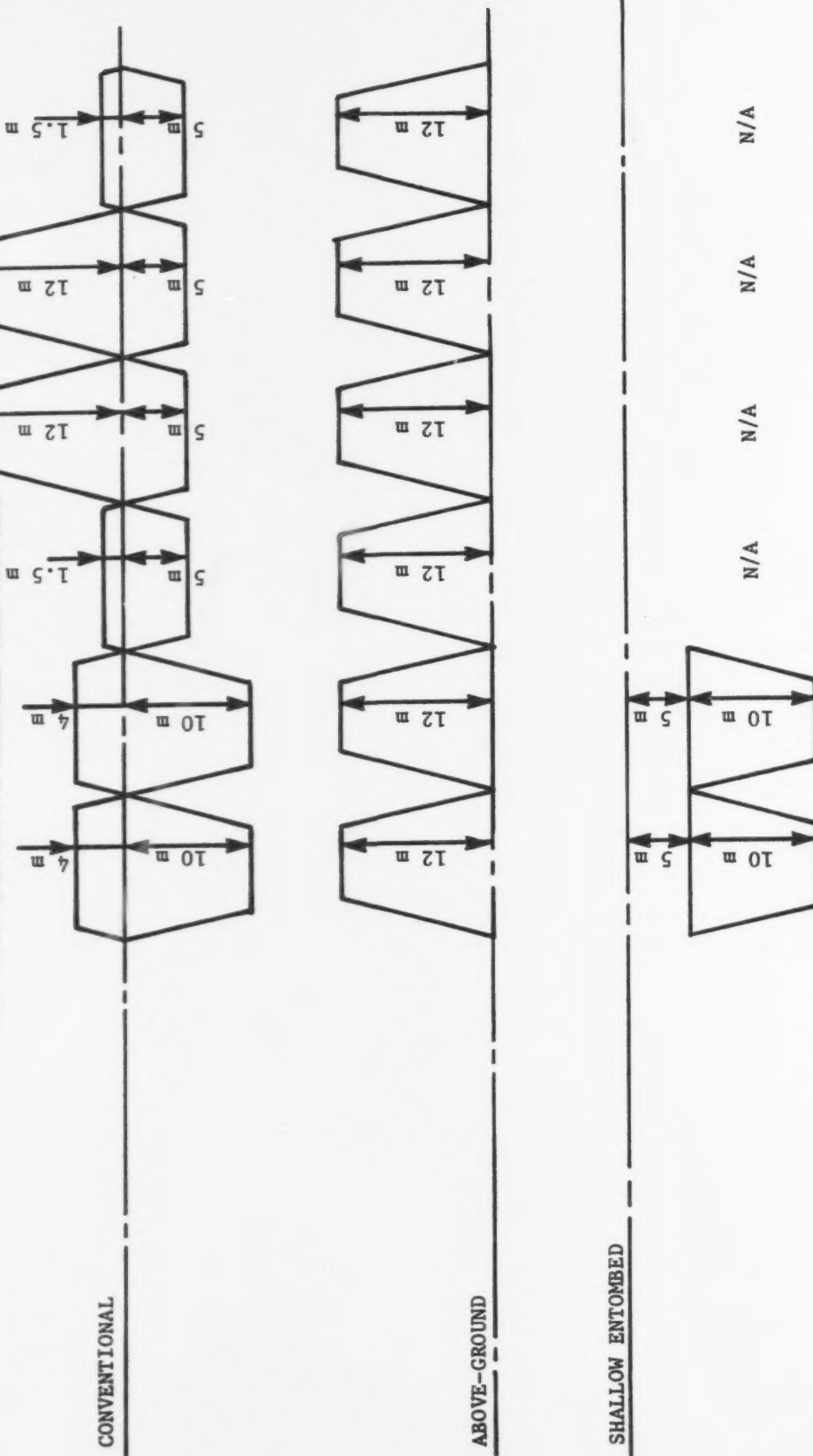
Gartner Lee Associates Limited (Ref: GLAL⁷) have identified sites which can potentially accommodate the various landfill design alternatives based on the hydrogeologic and geotechnical constraints discussed in Section 4.3.4 (p. 74) and their preliminary hydrogeologic assessment. These are presented in Table 6.7.

The work performed by Gartner Lee Associates Limited (Ref: GLAL⁷), at the level of information available during Phase 4A, indicates that all of the sites designated as suitable for landfill (i.e. LF sites) can potentially accommodate the alternative landfill types as shown on Table 6.7. OWMC (Ref: OWMC²³) identified that as part of their objectives, no matter which landfill type was ultimately selected, it would be designed to provide for the safe disposal of the solidified residues in a manner which would not result in harmful impact on human health or the environment.

TABLE 6.7

SITES WHICH CAN POTENTIALLY ACCOMMODATE THE VARIOUS LANDFILL DESIGN ALTERNATIVES

AND THEIR RESPECTIVE LANDFILL CELL PROFILES



CASE 1 INTEGRATED		CASE 2 LANDFILL SEPARATE		
LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-1E/ PI-27E

As can be seen from Table 6.7, candidate sites LF-9C and LF-3C provide maximum flexibility in that they can potentially accommodate all three of the landfill types being considered by OWMC, whereas LF-4N and LF-1E provide limited flexibility in that they can only potentially accommodate two of the landfill types (conventional and above-ground).

Effluent Disposal Option

As discussed in Section 6.4.4 (p. 122), OWMC are considering a number of options for the ultimate disposal of treated effluent from the physical/chemical treatment plant (Ref: OWMC²³). These options are:

- evaporation with discharge of water vapour to atmosphere,
- treatment in the solidification plant and disposal in the engineered landfill,
- discharge via pipeline to a receiving water body (Lake Ontario or Lake Erie) or sewer system,
- trucking to a receiving body or sewer system, and
- deep well injection.

As part of Phase 4A site selection, OWMC directed the site selection team to conduct an overview of these effluent disposal options in order to ascertain whether the selection of any option would be constrained by the selection of any siting option (Ref: MMD16). This overview analysis determined that none of the siting options under consideration would constrain the selection of any effluent disposal option (Ref: MMD16).

On this basis (effluent disposal option), the siting options can be considered equal in terms of engineering flexibility.

6.4.5.2 Facility Layout

Alternative physical arrangements for OWMC's Treatment Facility will be examined for the preferred site(s) during the finalization of the site-specific design in Phase 4B. Furthermore, impact assessment work is to be conducted in Phase 4B which might identify specific preferences regarding facility orientation and buffer zone requirements. OWMC may also wish to consider opportunities for expansion of the engineered landfill, if required, in the future.

The following aspects were reviewed to determine if the selection of any siting option would significantly constrain future site-specific engineering development:

- conceptual arrangement,
- rail access for the bulk delivery of additives and reagents,
- location of incinerator stack,
- expansion of technical buffer zone, and
- expansion of landfill area.

Conceptual Arrangement

As discussed in Section 4.3.1 (pp 71, 72) two conceptual arrangements of the Facility have been developed for Phase 4A site selection, namely:

- modular (as shown on Figure D.1 in Appendix D), and
- rectangular (as shown on Figure D.5 in Appendix D).

Both arrangements offer acceptable layouts with advantages and disadvantages, which will be investigated during Phase 4B, as the conceptual arrangement is finalized for the preferred site(s). As discussed in Section 4.3.1 (pp 71, 72), LF-9C cannot accommodate the modular layout due to buffer zone constraints. In addition, PI-27E cannot accommodate the

rectangular layout due to the ConRail track and hydro powerline which diagonally bisect the site. All other siting options can accommodate both conceptual arrangements. However, the inability of a site to provide the flexibility to accommodate both conceptual arrangements is not seen as a major constraint to the design development of the Facility.

Rail Access for the Bulk Delivery of Additives and Reagents

OWMC identified (Ref: OWMC²²) that the analysis of rail access options to each site (discussed in Chapter 3) was to be based on the assumption that rail service is not an absolute requirement for facility operations. OWMC further determined (Ref: OWMC²²) that rail services would be treated as an opportunity to be realized only if these services offered significant advantages - eg. reduced truck volumes - and that these advantages would not be offset by the major impacts and costs associated with rail service.

The analysis of rail access options concluded that rail access was feasible to every site with the exception of PI-13N, where the associated impacts and costs appeared to outweigh the benefits. This is discussed in "Background Material for the OWMC Phase 4A Site Selection Workshops, Volumes 1 & 2" (Ref: OWMC²²) and "Site Selection Process Phase 4A: Selection of Preferred Site(s) - Site Selection" (Ref: MMD¹⁶).

Because rail access was not an absolute requirement, but rather an opportunity that OWMC may realize at some future time, it was not included in the main comparative evaluation of siting options. However, rail access was incorporated into the conceptual arrangements (as shown on Figures D.1, D.2, D.3, D.4 and D.5 in Appendix D) and, where assessed to be feasible for a specific siting option, was incorporated into the "Site Layout" and "Service Connection" Figures in Appendix D for the purpose of the rail access analysis discussed in Chapter 3 (p. 55) and for the sensitivity analysis of transportation of additives and reagents by rail discussed in Section 6.4.2 (p. 121).

At candidate site PI-13N, where rail access is not considered to be feasible, the bulk transportation of additives and reagents can be achieved by trucking. This method was used by the site selection team in the comparative evaluation of siting options with rail access reviewed as part of a sensitivity analysis (Ref: MMD16).

Therefore, the inability of PI-13N to provide the flexibility for rail access is not seen as a major constraint to the design development or operation of the Facility.

Location of Incinerator Stack

The location of the incinerator stack is constrained at candidate site PI-1N by the flight path from Burlington Airpark nearby (Ref: MMD17). This constraint impacts on the facility layout to a minor extent and can be mitigated by orientating the facility layout with respect to the site as shown on Figure D.15 in Appendix D, so that the incinerator stack is located outside of Burlington Airpark's flight path constraint.

The location of the incinerator stack and hence incineration plants is also constrained at LF-9C by the requirement to accommodate the technical buffer zone within the site acquisition boundary. The technical buffer zone (p. 33) is a 400 m zone measured from the physical/chemical treatment plant, the physical/chemical tank storage, the incinerator tank farm, the tank truck unloading bays including incinerator waste receiving tanks and the drum storage and handling building as shown on Facility Layout Figures D.5 and D.8 in Appendix D. In order to achieve the technical buffer zone requirement, the location of the incinerator stack is limited to the north or south end of the site.

The inability of PI-1N and LF-9C to provide total flexibility in locating the incinerator stack and hence the incineration plant at any position during finalization of the conceptual facility layout is not seen as a major constraint.

Expansion of Technical Buffer Zone

During the design development and finalization of the facility layout, the size of the central operating area may require to be changed, which in turn may require modification to the extent of the 400 m technical buffer zone. M.M. Dillon Limited (Ref: MMD¹⁵) identified that the 400 m technical buffer zone had to be contained within the site acquisition boundary at each candidate site.

This aspect of the flexibility analysis estimates the ability of each siting option to provide for a possible increase in the extent of the technical buffer zone. Upon review of the "Site Layout" figures in Appendix D, it can be seen that all siting options can accommodate an increase in the technical buffer zone, although LF-9C provides the least flexibility in this respect. However, although this could constrain the engineer in finalizing the conceptual layout, the engineering studies, carried out as part of the design development, indicate that the conceptual facility layout can be accommodated on LF-9C. Therefore, the limited flexibility at LF-9C to provide for an expansion of the technical buffer zone is not seen as a major constraint.

Expansion of Landfill Area

As discussed in Section 6.2 (p. 105), there are several factors which can influence the landfill life which may be expected at any siting option. A need for additional land may be identified at some future date, to extend the landfill life capability of the preferred site(s).

This aspect of the flexibility analysis examines the ability of each siting option to provide for a possible increase in landfill area that is not severely constrained by roads, rail lines or major utility easements. This ability is solely from an engineering perspective, with no account being taken of impacts to the environment.

From a review of the "Site Layout" Figures in Appendix D, and the constraints discussed in Chapter 4 (p. 70), it can be seen that:

- LF-9C is free to expand to the west.
- LF-3C is free to expand to the east.
- LF-1E is constrained by roads, rail lines and hydrogeologic considerations,
- LF-4N is constrained by roads and hydrogeologic considerations.

It can be seen that LF-1E and LF-4N do not provide the same flexibility as other sites to easily expand the area available for landfilling. However, this is not seen as a major constraint as OWMC have the option to utilize other locations should additional landfill area be required in the future.

6.4.5.3 Flexibility Analysis

The flexibility sub-indicators discussed in Sections 6.4.5.1 and 6.4.5.2 are presented in Table 6.8 which indicates that LF-3C provides the most flexibility.

However, from an engineering perspective, the flexibility to accommodate shallow entombed landfill and the relative ease with which the landfill area can be expanded are considered to be the two most important flexibility indicators. On this basis (flexibility), we consider that LF-9C is ranked a close second to LF-3C.

The remaining siting options are all ranked equal third following LF-3C and LF-9C.

TABLE 6.8
APPLICATION OF FLEXIBILITY FACTOR

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATOR	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE			
				LP-9C	LP-3C	LP-1E	LP-4N/PI-1M	LP-4N/PI-13N	LP-1E/PI-27E	
SITE	ENGINEERING	FLEXIBILITY	FACILITY DESIGN • LANDFILL DESIGN - CONVENTIONAL - ABOVE GROUND - SHALLOW - ENTOMBED • EFFLUENT DISPOSAL OPTION - EVAPORATION - TRUCKING - PIPELINE	+	+	+	+	+	+	
				+	+	+	+	+	+	
			FACILITY LAYOUT • CONCEPTUAL ARRANGEMENT - MODULAR - RECTANGULAR • RAIL ACCESS FOR BULK TRANSPORTATION OF ADDITIVES & REAGENTS • LOCATION OF INCINERATOR STACK • EXPANSION OF TECHNICAL BUFFER ZONE • EXPANSION OF LANDFILL AREA	- +	+	+	+	+	+	-

CHAPTER 7
PARTIAL SOLIDIFICATION WITH EVAPORATION

7.1 INTRODUCTION

The previous chapters of this report, culminating in the ranking of siting options, are based on a "Total Solidification" scenario, in which all liquid effluent from the physical/chemical treatment plant is solidified and sent to landfill. This maximizes the volume of solidified material going to landfill and results in a landfill life for all siting options which is generally less than the 20 years minimum stipulated by OWMC.

During Phase 4A, OWMC identified several alternatives under consideration for the disposal of treated effluent from the physical/chemical treatment plant (Ref: OWMC²³). An overview analysis was conducted in Phase 4A (Ref: MMD¹⁶) to assess these alternative effluent disposal options. The analysis had the prime objective of determining whether the selection of any of the alternative effluent disposal options under consideration would be constrained by the selection of any siting option.

The analysis determined that none of the siting options under consideration would constrain the selection of any of the effluent disposal options (Ref: MMD¹⁶).

Given this situation, the site selection team were required to include the effluent disposal option, "Partial Solidification with Evaporation" (where

treated effluent is evaporated and discharged to atmosphere, while residues are solidified prior to disposal in the engineered landfill) in a sensitivity analysis (Ref: MMD¹⁶), to determine whether this alternative, rather than total solidification, would affect the ranking of siting options resulting from their comparative evaluation.

An amended set of facility characteristics information was developed by Monenco to establish a basis for the sensitivity analysis for partial solidification with evaporation, to be conducted by members of the site selection team.

Chapter 2 detailed the facility characteristics information associated with total solidification and discussed the "worst case" approach that was established for developing this information. A similar "worst case" approach was adopted in establishing facility characteristics information incorporating evaporation as the means of effluent disposal.

Certain assumptions were made to establish a preliminary basis for assessing the performance of the Facility incorporating evaporation as a means of effluent disposal. The main postulates are as follows:

- Conservatively low assumptions on the likely solids content of inorganic waste delivered to the Facility, resulting in maximum quantities of treated effluent requiring disposal.
- Minimum re-use of treated effluent in the Facility, thus increasing the likely quantities of effluent requiring disposal.
- Maximum quantity of leachate generated in the landfill.
- The leachate will require treatment, thus increasing the quantities of effluent requiring disposal.
- Conservatively low assumptions on the reject rate from the reverse osmosis units of the physical/chemical treatment plant, based on the low solids content postulated for the inorganic waste delivered to the Facility. The rejects from this effluent polishing stage of the

inorganic waste treatment system go to the solidification plant with the maximum quantities of polished effluent then requiring disposal.

- Conservatively high assumptions on the quantity of final effluent bled off from the evaporators to control total solids and hence fouling and corrosion in the evaporators.

These assumptions establish a "worst case" basis which results in conservatively high estimates being made of the quantities of effluent being evaporated and discharged to atmosphere, while at the same time maximizing the volume of solidified material to be landfilled, thereby resulting in conservatively low estimates of landfill life.

The estimates of quantities of solidified material and hence landfill life developed for the partial solidification with evaporation scenario are considered reasonable for this comparative assessment of siting options. It should be recognized, however, that there are many variables which can influence the actual landfill life achieved. These are discussed in Chapter 6 (p. 105).

This chapter explains the effects of partial solidification with evaporation on:

- facility characteristics information,
- costs, and
- ranking of siting options.

7.2 FACILITY CHARACTERISTICS INFORMATION

The following facility characteristics information represents only those items which differ from the information presented in Chapter 2, as a result of using evaporation, rather than solidification for the disposal of treated effluent.

7.2.1 CONSTRUCTION OF THE FACILITY

Additional equipment for evaporation will consist of:

- Two single effect, forced recirculation evaporators installed initially with a third added when the Facility is expanded to 300 000 t/a capacity.
- Larger auxiliary boilers and associated equipment for the supply of plant steam.

7.2.2 OPERATION OF THE FACILITY

Differences in the characteristics associated with operation of the Facility are as follows:

7.2.2.1 Emissions and Effluents

For air quality studies the maximum rate of steam venting from the evaporator stack was estimated at 19.4 t/h at 100°C, with an exit velocity of 53 m/s.

7.2.2.2 Transportation Requirements

The quantities of special wastes and intersite transfers are shown on Table 7.1 (p. 143). The quantities of additives and reagents and assumed location of suppliers are shown on Table 7.2 (p. 144).

7.2.2.3 Anticipated Noise Levels

The anticipated noise level at the top of the evaporator stack has a sound power level PWL = 75dB (A). All other noise levels are identified in Table C-2 of Appendix C.

7.2.2.4 Visual Appearance

Additions to the architect's impression of the 300 000 t/a Facility shown on Figures D.6 and D.7 in Appendix D comprise one 7m x 15m x 16m high evaporator building with a 0.5m dia x 45m high stack and additional effluent holding ponds. The evaporator building will be located adjacent to the physical/chemical treatment building.

7.2.2.5 Hours of Operation

Operation of the evaporators will be 3 shifts/day, 7 days/week, up to 50 weeks/year.

7.2.2.6 Services for the Facilities

Services for the facilities are the same as shown in Tables 2.4 (Case 1) and 2.5 (Case 2) (pp. 49, 50) with the following exceptions:

Case 1 (Integrated)

- Surface Drainage 6040 t/day max,
- Natural Gas 92 GJ/h
- Fuel Oil 9600 t/a (LF-9C and LF-3C Only)

Case 2 (Landfill Separate)

- Surface Drainage
PI Site 3840 t/day max.
LF Site 2211 t/day max.
- Natural Gas 92 GJ/h

7.2.2.7 Employment Levels

The total employment levels for partial solidification with evaporation are:

- | | |
|------------------------------|-------------|
| - Case 1 (integrated) | 225 persons |
| - Case 2 (landfill separate) | 221 persons |

Note: For a rationale on the difference in employment levels between Case 1 and Case 2 see Section 2.2.3.9 (p. 39).

7.2.2.8 Taxation and Zoning

Areas of the candidate sites which can be zoned industrial are:

- Case 1 (integrated siting option) 70.4 ha
- Case 1 (integrated siting option LF-9C) 72.9 ha
- Case 2 (landfill separate siting option)
 - Phys/Chem/Incinerator site 17.7 ha
 - Separate landfill site 53.0 ha

7.3 COST

Tables 7.3 and 7.4 show the capital cost and annual operating costs, which have been estimated on the same basis as described in Chapter 5. Summary tables included in Appendix E, Tables E.7 to E.12, present similar detailed capital and operating costs to those presented for total solidification in Tables E.1 to E.6.

The difference in capital cost between the highest (LF-1E/PI-27E) and the lowest cost siting option (LF-3C) is approximately 2%. For annual operating costs, the difference between the highest (LF-3C) and the lowest cost siting option (LF-4N/PI-1N) is approximately 6%.

7.4 COMPARATIVE EVALUATION OF SITING OPTIONS

7.4.1 LANDFILL LIFE

The discussion of landfill life in Chapter 6 (p. 105) outlined alternative cell configurations and design optimization that will be examined after the

preferred siting option has been selected. Those comments will equally apply to the partial solidification with evaporation option. The estimated landfill lives for partial solidification with evaporation shown in Table 7.5, are calculated on the same basis as for total solidification. These are considered suitable for the comparative assessment of siting options in Phase 4A.

7.4.2 ECONOMIC ANALYSIS

An economic analysis performed using the same criteria describe in Chapter 6 (p. 110), resulted in the "Present Value of Lifecycle Annual Costs" and ranking of siting options shown in Table 7.6.

7.4.3 SENSITIVITY TESTING

Sensitivity testing was also conducted by varying the same key parameters as previously explained for total solidification in Chapter 6 (p. 118). The results of this sensitivity testing in respect of the economic analysis are presented in Table 7.7. Once again, there were no major changes to the ranking of siting options. In respect of transportation of additives and reagents by rail, partial solidification with evaporation requires considerably less cement and sodium silicate and therefore any potential cost benefits would be less than with total solidification.

The landfill lives for the parcel options on LF-3C and LF-1E are significantly improved by the use of partial solidification with evaporation. At LF-1E, however, the resulting site life before optimization is 21 years for Case 1 and 19.5 years for Case 2, as shown on Table 7.5, so the choice of a smaller land parcel would be marginal. At LF-3C, the resultant landfill life of 32.5 years implies that a smaller land parcel could be feasible although the reduction in capital cost would not affect the ranking.

TABLE 7.1

TRANSPORTATION QUANTITIES OF SPECIAL WASTES AND INTERSITE TRANSFERS

DESCRIPTION	CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE	
	PHYS/CHEM INCIN. LANDFILL	PHYS/CHEM INCINERATOR	LANDFILL
	Tonnes per year	Tonnes per year	Tonnes per year
Pumpable waste	205 600	205 600	-
Non-pumpable waste	85 400	85 400	
Drummed waste(Note 3)	9 000	9 000	
TOTAL WASTE	300 000	300 000	-
Solidified material to landfill	-	170 900	-
Granular material for drainage system in landfill	8 100	-	8 100
Slag from incinera- tion plant to landfill	-	7 600	
Leachate from landfill to phys/chem	-	-	26 100

- NOTES:**
1. Based on Partial Solidification with Evaporation.
 2. Quantities are for year 20, 300 000 t/a waste delivered.
 3. 3% of total waste delivered in 200 L (45 gal) drums.

TABLE 7.2
TRANSPORTATION QUANTITIES OF ADDITIVES
AND REAGENTS

ADDITIVE OR REAGENT	PHYSICAL STATE	QUANTITY DELIVERED PER YEAR	SOURCE SHIPPING LOCATION	COST \$ F.O.B. SUPPLIER
Cement	Powder	17 600 t	Mississauga	1,848,000
Sodium Silicate	Liquid	7 300 t	Etobicoke	1,292,000
Sulphur Dioxide	Liquid	100 t	Cornwall	78,000
Chlorine	Liquid	400 t	Cornwall	220,000
Caustic Soda	50% Liquid	6 240 t	Cornwall	1,254,000
Hydrated Lime	Solid	7 400 t	Toronto	542,000
Activated Carbon	Solid	100 t	Hamilton	540,000
Nitrogen	Liquid	24 000 Nm ³	Scarborough	15,000
Calcium Oxide	Solid	2 380 t	Ingersoll	167,000
Miscellaneous	-	-	-	974,000
Miscellaneous Consumables	-	-	-	150,000

- NOTES:**
1. Based on Partial Solidification with Evaporation.
 2. Quantities are for year 20, 300 000 t/a waste delivered.
 3. Alternative chemicals, sodium bisulphite and sodium hypochlorite are being considered to replace sulphur dioxide and chlorine respectively.

**CAPITAL COST ESTIMATE - 300 000 t/a CAPACITY
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS**

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED				CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E		LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	ENGINEERING	CAPITAL COST	INCINERATION	58828	58828	58828		58828	58828	58828
			PHYSICAL/CHEMICAL TREATMENT	46836	46836	46836		46836	46836	46836
			SOLIDIFICATION	11808	11808	11808		11808	11808	11808
			ON-SITE FACILITIES	58519	58519	58519		58519	58519	58519
			ENGINEERED LANDFILL	5008	5207	5731		4691	4691	5513
			ON-SITE FACILITIES (SITE SPECIFIC)	13483	11089	10349		11597	11131	12822
			OFF-SITE FACILITIES	2371	2006	3490		2872	4467	3090
			TOTAL ESTIMATED COST	196853	194293	195561		195150	196280	197416

NOTE: All costs shown in 1984 thousand dollars (Canadian).

TABLE 7.4

ANNUAL OPERATING COSTS
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	ENGINEERING	OPERATING COST SUMMARY	YEAR -1	3600	3600	3600	3600	3600	3600
			1	20304	20337	19346	19345	19449	19468
			2	18175	18081	17969	17303	17409	18031
			3	21046	21003	20702	19974	20086	20759
			4	22818	22813	22373	21644	21762	22470
			5	24320	24343	23797	22985	23106	23863
			6	32617	32757	31910	30955	31088	32069
			7	32244	32403	32207	30709	30841	32468
			8	34151	34339	34909	32497	32642	34320
			9	36361	36593	36119	34524	34667	36397
			10 - 20	38331	38607	37989	36386	36534	38307
			21	14900	14900	14900	14900	14900	14900
			22	200	200	200	200	200	200

NOTE: All costs shown in 1984 thousand dollars (Canadian)

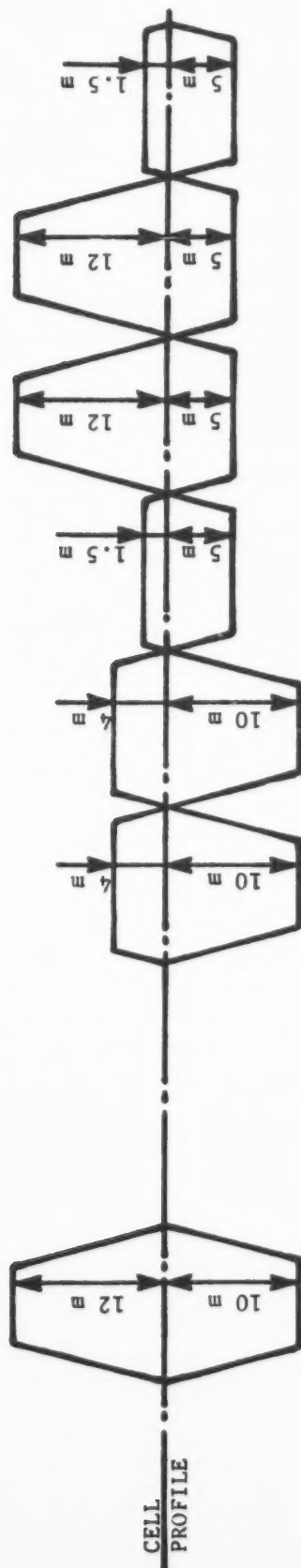
TABLE 7.5

LANDFILL LIFE

PARTIAL SOLIDIFICATION

300 000 t/a CAPACITY

CONVENTIONAL LANDFILL



BASE CASE

STUDY AREA	GROUPING	FACTOR	INDICATOR	CASE 1 INTEGRATED			CASE 2 LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N PI-1N	LF-4N PI-13N	LF-1E PI-27E
SITE	ENGINEERING	SITE AREA	LANDFILL LIFE (YEARS) PARTIAL SOLIDIFICATION	23.5	32.5	21	24.5	24.5	19.5

TABLE 7.6

**OVERALL RANKING OF COSTS
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS**

STUDY AREA	FACTOR GROUPING	CASE 1 - INTEGRATED SITE			CASE 2 - LANDFILL SEPARATE		
		LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	COST (Present Value of Lifecycle Annual Costs)	544	543	539	524	527	543
OPTION RANKING		5	4	3	1	2	4

NOTE: All costs are shown in 1984 million dollars (Canadian)

TABLE 7.7

**OVERALL RANKING OF COSTS
SENSITIVITY TESTING
PARTIAL SOLIDIFICATION WITH EVAPORATION**

VARIATION	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
	LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
CAPITAL COST +30%	596	595	591	576	579	595
RANKING	5	4	3	1	2	4
CAPITAL COST +18%	513	512	508	493	496	511
RANKING	6	5	3	1	2	4
OPERATING COST +30%	652	651	645	627	630	650
RANKING	6	5	3	1	2	4
OPERATING COST -18%	479	478	475	463	465	478
RANKING	5	4	3	1	2	4
COST OF CAPITAL +2% (i.e. 13%)	431	430	427	416	418	430
RANKING	5	4	3	1	2	4
COST OF CAPITAL -2% (i.e. 9%)	703	702	696	676	680	701
RANKING	6	5	3	1	2	4
ESCALATION RATE +2% (i.e. 9%)	706	706	700	680	683	704
RANKING	5	5	3	1	2	4
ESCALATION RATE -2% (i.e. 5%)	425	424	421	411	413	424
RANKING	5	4	3	1	2	4
30 YEAR LIFE CYCLE	660	661	654	635	638	659
RANKING	5	6	3	1	2	4
150 000 t/a CAPACITY 20 YR. LIFE CYCLE	407	404	400	393	395	402
RANKING	6	5	3	1	2	4

NOTE: Costs are present value of life cycle annual costs in 1984 million dollars
(Canadian)

CHAPTER 8

CONCLUSIONS

8.1 INTRODUCTION

Chapter 6 of this report addressed the comparative evaluation of siting options from an engineering perspective, based on the premises established for Phase 4A site selection, and illustrated the relative differences between siting options in terms of:

- landfill life, and
- facility cost.

The results of the comparative evaluation were then subjected to a sensitivity analysis to estimate the effects on landfill life and costs by:

- Varying the economic criteria used in the economic analysis, which ranked siting options on the basis of the present value of life cycle costs.
- Using rail for transportation of bulk additives and reagents.
- Reducing the size of two of the landfill sites (LF-3C and LF-1E).
- Operating in the partial solidification with evaporation mode, where the treated effluent is evaporated to atmosphere, versus the total solidification mode, where the treated effluent is solidified and disposed of in an engineered landfill.

One further aspect of the sensitivity testing included an analysis of engineering flexibility to determine if the design development of the Facility (which is proceeding in parallel with and beyond Phase 4A site selection) would be significantly constrained by the selection of any siting option.

This chapter reviews the results of the comparative evaluation from an engineering perspective, and presents recommendations of how engineering considerations should be utilized in the overall site selection process.

8.2 LANDFILL LIFE

Chapter 6 (p. 105) identified the alternate types of engineered landfill and effluent disposal options that OWMC are considering for their Treatment Facility and examined the premises and assumptions which affect the landfill life estimates. The comparative evaluation of siting options illustrated the major effect that the choice of effluent disposal method has on achievable landfill life.

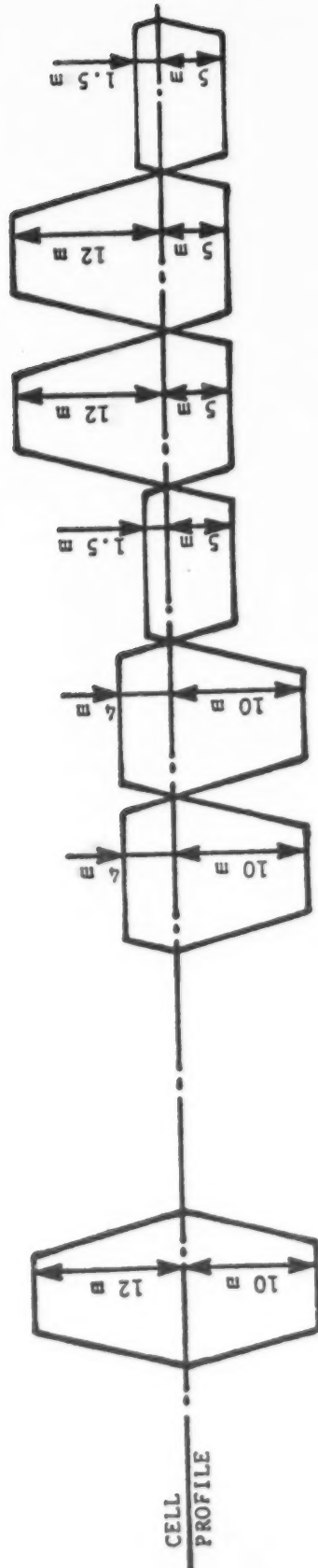
The estimated landfill lives for both methods of effluent disposal, based on conventional landfill, are presented in Table 8.1, which shows that, under the total solidification mode, none of the siting options satisfy OWMC's criterion of a minimum landfill life of 20 years, whereas in the case of partial solidification with evaporation, all siting options substantially meet or better twenty years of landfill life.

TABLE 8.1

LANDFILL LIFE

COMPARATIVE EVALUATION OF SITING OPTIONS

CONVENTIONAL LANDFILL



BASE CASE

STUDY AREA	FACTOR GROUPING	FACTOR	INDICATOR	CASE 1 INTEGRATED			CASE 2 LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/PI-1N	LF-4N/PI-13N	LF-1E/PI-2/E
SITE	ENGINEERING	SITE AREA	LANDFILL LIFE (YEARS) TOTAL SOLIDIFICATION	14	19	12	15.5	15.5	11
			LANDFILL LIFE (YEARS) PARTIAL SOLIDIFICATION	23.5	32.5	21	24.5	24.5	19.5

8.3 COST

8.3.1 TOTAL SOLIDIFICATION

Chapter 5 of this report addressed the total cost of constructing and operating OWMC's Treatment Facility over a period of twenty years, based on total solidification. Figure 5.1 (p. 96) illustrated that, on average, 89% of the estimated capital cost was common to all siting options, while the remaining 11% varied due to costs specific to each siting option. Comparison of the total capital cost for each siting option shows that the total range of variation is less than 2 1/2%, from \$189 533 000 at LF-3C to \$194 002 000 at LF-1E/PI-27E (see Table 5.1 p. 95).

Examination of the facility operating costs for year 10, when the Facility is operating at its maximum potential capacity of 300 000 t/a, reveals that the site specific variable costs such as transportation, utilities and engineered landfill account for about 28% of the total operating costs (see Figure 5.2 p. 103). The remaining 72% of operating costs are common to all siting options. Comparison of the operating cost for year 10 shows that the total range of variation is less than 10%, from \$42 295 000 at LF-4N/PI-1N to \$46 398 000 at LF-1E/PI-27E (see Table 5.2 p. 102).

An economic analysis was performed to determine the equivalent capital amount, stated in 1984 dollars, required to offset the total capital and operating costs to be expended over the 20 year operating period, as a basis for the comparative evaluation of siting options. Due to the small relative differences in costs between the siting options, the results of the economic analysis expressed as the present value of life cycle cost, vary within 7%, ranging from \$567 million at LF-4N/PI-1N to \$606 million at LF-1E/PI-27E (see Table 6.3 p. 117).

The siting options can then be ranked based on the results of the economic analysis, as follows:

<u>Siting Option</u>	<u>Cost Order</u>	<u>Ranking</u>
LF-4N/PI-1N	1 (lowest cost)	1
LF-4N/PI-13N	2	2
LF-9C	3	3
LF-3C	3	3
LF-1E	4	4
LF-1E/PI-27E	5 (highest cost)	5

8.3.2 PARTIAL SOLIDIFICATION WITH EVAPORATION

The effect on costs of introducing partial solidification with evaporation as the alternative method of effluent disposal is that:

- capital costs increase, and
- operating costs decrease.

The capital costs increase due to the requirement for additional equipment, evaporators and larger auxiliary boilers. However, when the equalization of land acquisition costs to achieve a landfill life of 20 years at each siting option (as described in Chapter 6 p. 112) is included, the overall variation is within 2% (less than that for total solidification), ranging from \$194 293 000 at LF-3C to \$197 416 000 at LF-1E/PI-27E (see Table 7.3 p. 145).

The operating costs decrease due to a reduction in the requirement for solidification reagents, offset somewhat by an increase in utilities to generate the steam required for evaporation, with the overall variation being within 6% (less than that for total solidification), ranging from \$36 386 000 at LF-4N/PI-1N to \$38 307 000 at LF-3C (see Table 7.4 p. 146).

The results of the economic analysis, expressed as the present value of life cycle cost, show a variation within 4%, ranging from \$524 million at LF-4N/PI-N to \$544 million at LF-9C (see Table 7.7 p. 149). This cost spread is less than that previously indicated for total solidification (p. 153).

The siting options can then be ranked in the following order of cost, based on the results of the economic analysis as follows:

<u>Siting Option</u>	<u>Cost Order</u>	<u>Ranking</u>
LF-4N/PI-1N	1 (lowest cost)	1
LF-4N/PI-13N	2	2
LF-1E	3	3
LF-1E/PI-27E	4	4
LF-3C	4	4
LF-9C	5 (highest cost)	5

8.3.3 SENSITIVITY ANALYSIS EFFECTS ON RANKING

Sensitivity analyses were conducted as part of the comparative evaluation process to test the assumptions used in the economic analysis. The results of the sensitivity analyses show that the following variations have minimal effect on cost ranking:

- Changing the economic inputs and assumptions used in the economic analysis.
- Transporting additives and reagents to site by rail.
- Changes to the site size at candidate sites LF-3C and LF-1E.
- Use of partial solidification.

In respect of engineering flexibility, it was determined that different siting options exhibited differing flexibility in being able to accommodate the various options being considered by OWMC and provide a greater degree of freedom to the engineer (Monenco Limited) to produce the optimal design.

However, although the differences in flexibility between siting options are not viewed as a major constraint to OWMC or their engineer in finalizing a satisfactory conceptual design for the preferred site(s), LF-3C and LF-9C are ranked higher than the other siting options due to their ability to accommodate all three landfill types under consideration (p. 127) and the relative ease with which their landfill areas could potentially be expanded (p. 133).

8.4 RECOMMENDATIONS

Based on the small cost differences between siting options resulting from the economic analysis, expressed in percentage terms (pp. 153, 154), and taking into account the preliminary nature of the capital and operating cost estimates, Monenco recommends that the cost factor be given low importance in the selection of a preferred site(s). This is also consistent with OWMC's Corporate goals with cost being rated of lower importance than matters dealing with human health and environmental impacts.

There is considerable variation in landfill lives between siting options and in the case of total solidification, none of the siting options achieve OWMC's minimum requirement of twenty years. The introduction of partial solidification with evaporation as the alternative effluent disposal option improves the landfill lives such that all of the siting options substantially meet or better twenty years of landfill life.

However, several factors discussed in Chapter 6 (p. 105) can influence the landfill life which may be expected at any siting option, due to any or a combination of these factors, but particularly:

- Method of effluent disposal option selected in Phase 4B.
- Type of engineered landfill design selected in Phase 4B.

- Variation in the actual quantities and characteristics of special waste to be treated at the Facility as well as the rate of build up of special waste with time.
- Specific details of the engineered landfill design.

In addition, the engineering flexibility analysis indicates that although the considerable variations between siting options (in terms of engineering flexibility) are not considered as a major constraint in finalizing a satisfactory conceptual design, some of the siting options preclude the option for shallow entombed landfill and/or restrict the potential for expansion of landfill area should a need be identified at some future date. From a flexibility basis, LF-3C which provides the most flexibility is ranked first with LF-9C a close second and the remaining siting options all ranked equal third.

We recommend that the achievable landfill life be re-examined in Phase 4B for the preferred site(s), once the method of effluent disposal, type and details of landfill design have been determined.

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APPENDIX A

FACTOR SHEETS

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

LEAD CONSULTANT: MONENCO LIMITED

FACTOR GROUPING: ENGINEERING

FACTOR: SITE AREA

FACILITY COMPONENTS AFFECTED: OWMC TREATMENT FACILITY

FACTOR APPLIED FOR FOLLOWING OPTIONS:

Access Roads

No

Rail Access

Yes

**Refinement of Site
Boundaries**

Yes

**Location of Physical/Chemical
Treatment Plant**

Yes

Siting Option Comparison

Yes

Other

None

DEFINITION OF FACTOR: The site area is the size of land parcel required to accommodate the OWMC Treatment Facility including the 400 metre technical buffer zone. For those sites which include landfill, the site size has to be large enough to accommodate landfill sufficient for a minimum life of 20 years plus a 50 metre buffer zone.

RATIONALE/SIGNIFICANCE OF FACTOR: This factor addresses the rationale for accepting or rejecting a candidate site based on the adequacy of the site to accommodate the Facility including the 400 metre technical buffer zone, and/or landfill including its 50 metre buffer zone and 20 year landfill site life.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

INTERPRETATION/METHODOLOGY: Modular facility layouts at a scale of 1:10 000 were developed for the three cases of siting combination identified in OWMC's Phase 3 Report, (Ref: OWMC²¹):

- Case 1 - Integrated Siting Option: Incineration plant and physical/chemical treatment plant (including solidification) and engineered landfill all on one site.
- Case 2 - Landfill Separate Siting Option: Incineration plant, physical/chemical treatment plant (including solidification) at the PI site, with the engineered landfill at the LF site.
- Case 3 - Incineration Separate Siting Option: Incineration plant at the PI site, with physical/chemical treatment plant (including solidification) and engineered landfill at the LF site.

A technical buffer zone of 400 metres (Ref: MMD¹⁵) was superimposed on the facility layouts. The facility layouts, complete with technical buffer zone, were then superimposed on 1:10 000 scale maps of each candidate site land parcel in accordance with the specific siting options, to locate and orientate the Facility in accordance with the preferred road and rail access and constraint mapping developed during Phase 4A (Ref: MMD¹⁶).

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

FACTOR GROUPING: ENGINEERING

FACTOR: SITE AREA

INDICATORS: (1) SITE SIZE

CONSULTANT: MONENCO LIMITED

DEFINITION: This indicator addresses the land parcel requirements to accommodate the OWMC Treatment Facility including technical buffer zones.

RATIONALE/SIGNIFICANCE: The site area has to be large enough to accommodate the 300 000 t/a capacity Facility and/or separate landfill including a technical buffer zone of 400 metres from sources of emissions within the central operating area and a 50 metre buffer zone around the landfill (Ref: MMD¹⁵).

SOURCES OF INFORMATION: In-house modular facility layouts developed in accordance with the design basis established for Phase 4A.

INPUTS FROM OTHER CONSULTANTS: None.

STUDY AREA: The eight candidate sites identified in OWMC's Phase 3 Report, (Ref: OWMC²¹).

COMMENTS/ASSUMPTIONS/LIMITATIONS: The 400 metre technical buffer zone for fugitive emissions is measured from the physical/chemical treatment plant, the physical/chemical tank storage, the incinerator tank farm, the tank truck unloading bays, including the incinerator waste receiving tanks, and the drum storage and handling building.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: SITE AREA
FACILITY COMPONENTS AFFECTED: OWMC TREATMENT FACILITY	
INDICATOR: (2) LANDFILL LIFE	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the landfill life that can be obtained for a Case 1, Case 2 or Case 3 siting option.	
RATIONALE/SIGNIFICANCE: A landfill life of 20 years was identified by OWMC as the minimum landfill life acceptable (Ref: OWMC²³).	
SOURCES OF INFORMATION: In-house modular facility layouts developed in accordance with the design basis established for Phase 4A. Landfill lives were estimated by M.M. Dillon Limited (sub-consultant to Monenco Limited).	
INPUTS FROM OTHER CONSULTANTS: Gartner Lee Associates Limited identified floodplain constraints (Ref: GLAL⁸) and hydrogeologic/geotechnical constraints (Ref: GLAL⁷), which have been taken into account.	
STUDY AREA: The five candidate sites identified in OWMC's Phase 3 Report, (Ref: OWMC²¹) which may be considered suitable for an engineered landfill.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

COMMENTS/ASSUMPTIONS/LIMITATIONS: The site area available for landfill for a Case 1 and Case 3 siting option is assumed to be the site area of the landfill site between the central operating area perimeter fence and the landfill perimeter fence less the 50 metre buffer zone, access road and rail spur. For a Case 2 siting option, the site area available for landfill is assumed to be the total site area of the landfill site within the perimeter fence less the 50 metre buffer zone and access road.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION		
LEAD CONSULTANT: MONENCO LIMITED		
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST	
FACILITY COMPONENTS AFFECTED: OWMC TREATMENT FACILITY		
FACTOR APPLIED FOR FOLLOWING OPTIONS:		
Access Roads No	Rail Access Yes	Refinement of Site Boundaries No
Location of Physical/Chemical Treatment Plant Yes	Siting Option Comparison Yes	Other None
DEFINITION OF FACTOR: The capital cost is the total estimated cost to engineer, procure and construct the OWMC Treatment Facility.		
RATIONALE/SIGNIFICANCE OF FACTOR: This factor addresses the capital costs associated with locating an OWMC Treatment Facility at the siting options and quantifies the incremental cost differences between siting options.		
INTERPRETATION/METHODOLOGY: Capital costs of the operating area will be estimated for a 150 000 t/a integrated Facility (since preliminary engineering is well advanced for this level of estimate) and then adjusted to take into account expanding the Facility to 300 000 t/a for each of the siting options. Capital costs of the engineered landfill will be estimated for site development of the landfill area, equipment, buildings and construction of the		

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

INTERPRETATION/METHODOLOGY: (Cont'd)

first landfill cell based on the initial quantities of solidified material to be landfilled. Expansion of the engineered landfill to accommodate the increased throughput of the OWMC Treatment Facility is reflected in the operating cost factor.

An allowance of 15% of total costs, except land acquisition costs, will be factored in to take into account engineering, procurement and construction management costs (EPCM costs). A further allowance of 20% is applied to the total costs, except land acquisition costs, to cover contingencies which provides for unknown or unforeseen situations which may occur during final design and construction.

Excluded from the capital cost factor are OWMC costs and consulting and engineering costs incurred during the five phase Facilities Development Process.

The accuracy of the estimate is judged to be in the order of plus 30%, minus 18%.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (1) INCINERATION	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses all capital costs associated with the incineration plant, including rotary kiln incinerators and secondary combustion chambers, waste heat recovery boilers, flue gas treatment systems and stack, auxiliary boilers and associated water treatment plant, associated buildings and incinerator tank farm.	
RATIONALE/SIGNIFICANCE: The incinerator was identified in Phase 4A (Ref: OWMC²³) as the process technology for high-temperature thermal destruction of organic special waste, and has been further developed during Phase 4A (Ref: MONENCO¹⁹).	
SOURCES OF INFORMATION: In-house equipment list and facility layouts developed in accordance with the design basis established for Phase 4A and incineration technology provided by Environmental Elements Corporation and Von Roll Ltd., and Hessische Industriemüll GmbH.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The six candidate sites, identified in OWMC's Phase 3 Report, (Ref: OWMC²¹) which may be considered as suitable for an incineration plant.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment and building costs are estimated in-house. The installed cost of equipment including civil, electrical, instrumentation and piping are estimated by applying in-house modular factors to the equipment costs.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (2) PHYSICAL/CHEMICAL TREATMENT	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses all capital costs associated with the physical/chemical treatment plant including physical/chemical tank storage, inorganic waste treatment system, aqueous organic waste treatment system, miscellaneous waste treatment system, and associated building.	
RATIONALE/SIGNIFICANCE: Physical/chemical treatment was identified in Phase 3 (Ref: OWMC²¹) as the process technology for breaking down, detoxifying, removing immiscible organics from inorganics and reducing the volume of wastes, and has been further developed during Phase 4A (Ref: MONENCO¹⁹).	
SOURCES OF INFORMATION: In-house equipment lists and facility layouts developed in accordance with the design basis established for Phase 4A.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The eight candidate sites, identified in OWMC's Phase 3 Report, (Ref: OWMC²¹) which may be considered as suitable for a physical/chemical treatment plant.	
COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment and buildings are estimated in-house. The installed cost of equipment including civil, electrical, instrumentation and piping are estimated by applying in-house modular factors to the equipment costs.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (3) SOLIDIFICATION	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator address all capital costs associated with the solidification plant including low solids process, high solids process, storage vessels and associated building.	
RATIONALE/SIGNIFICANCE: Solidification was identified in Phase 3 (Ref: OWMC²¹) as the process technology for converting innocuous wastes and residues from physical/chemical treatment and incineration into a solid form for placement in an engineered landfill, and has been further developed during Phase 4A (Ref: MONENCO¹⁹).	
SOURCES OF INFORMATION: In-house equipment list and facility layouts developed in accordance with the design basis established for Phase 4A and solidification technology provided by Chem-Technics Inc. (sub-consultant to Monenco).	
INPUTS FROM OTHER CONSULTANTS: None	
STUDY AREA: The eight candidate sites, identified in OWMC's Phase 3 Report, (Ref: OWMC²¹) which may be considered as suitable for a solidification plant.	
COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment and building costs are estimated in-house. The installed cost of equipment including civil, electrical, instrumentation and piping are estimated by applying in-house modular factors to the equipment costs.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (4) ON-SITE FACILITIES	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses all capital costs associated with the on-site facilities including site work and site improvements, service and maintenance buildings, spare parts inventory, material handling facilities, roads and parking areas, spillage and surface drainage containment, and services such as electricity, water, sewers, telephones and fire protection.	
RATIONALE/SIGNIFICANCE: The on-site facilities were identified in Phase 3 (Ref: OWMC²¹) and have been further developed during Phase 4A (Ref: MONENCO¹⁹). They are required for the safe and efficient operation of the OWMC Treatment Facility.	
SOURCES OF INFORMATION: In-house equipment list and facility layouts developed in accordance with the design basis established for Phase 4A.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The eight candidate sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹).	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment and buildings are estimated in-house. The installed cost of equipment including civil, electrical, instrumentation and piping are estimated by applying in-house modular factors to the equipment costs. An allowance of \$1 million has been included for spare parts and an allowance of \$400,000 has been included to cover landscaping.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (5) ENGINEERED LANDFILL	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the capital costs associated with the engineered landfill including initial development of the landfill area, equipment to transport and place the solidified material, buildings and construction of the first landfill cell.	
RATIONALE/SIGNIFICANCE: The engineered landfill was identified in Phase 3 (Ref: OWMC²¹) as the process technology for secure disposal of solidified residues of the treatment processes, and has been further developed during Phase 4A (Ref: MONENCO¹⁹).	
SOURCES OF INFORMATION: Equipment list and facility layouts developed in accordance with the design basis established for Phase 4A and landfill technology provided by M.M. Dillon Limited (sub-consultant to Monenco).	
INPUTS FROM OTHER CONSULTANTS: Hydrogeologic/geotechnical constraints which affected the landfill cell design and layout were identified by Gartner Lee Associates Limited (Ref: GLAL⁷).	
STUDY AREA: The five candidates sites, identified in OWMC's Phase 3 Report (Ref: OWMC²¹) which may be considered as suitable for an engineered landfill.	
COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment, buildings, site development and cell construction costs are estimated in-house by M.M. Dillon Limited.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: CAPITAL COST
INDICATORS: (6) ON-SITE FACILITIES (SITE SPECIFIC)	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses all capital costs associated with the on-site facilities which are site specific. They include land acquisition, water treatment for sites for which a municipal water supply is not available, fuel oil storage for sites for which natural gas is not available, sewage treatment for sites not serviced by municipal sanitary sewers, seismic design and piling requirements, backfilling of the central operating area (where required) to improve natural containment, excavation of archaeological sites, provision of a cattle crossing at LF-3C access road and revisions to facility layouts to accommodate the technical buffer zones within the site acquisition boundaries.	
RATIONALE/SIGNIFICANCE: The on-site facilities (site specific) were developed during Phase 4A. They are required for the safe and efficient operation of the OWMC Treatment Facility.	
SOURCES OF INFORMATION: In-house equipment list and facility layouts developed in accordance with the design basis established for Phase 4A. Seismic design was based on the requirements of the Ontario Building Code.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

INPUTS FROM OTHER CONSULTANTS: In respect of land acquisition, costs were estimated by Graydon Rogers Appraisals Limited, based on the candidate site land parcels identified by M.M. Dillon Ltd. (Ref: MMD¹⁶). Piling requirements were identified by Gartner Lee Associates Limited (Ref: GLAL⁷). Backfilling to improve natural containment was identified by Gartner Lee Associates Limited (Ref: GLAL⁷). Excavation of archaeological sites including associated costs was identified by the Museum of Indian Archaeology (Ref: GLAL⁹). Provision for a cattle crossing on the access road to LF-3C was identified by Ecologistics Ltd. (Ref: ECOL³) and cost information provided by M.M. Dillon Ltd. (Ref: MMD¹⁷).

STUDY AREA: The eight candidate sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹).

COMMENTS/ASSUMPTIONS/LIMITATIONS: The equipment and buildings seismic design, piling and backfilling are estimated in-house. The installed cost of equipment including civil, electrical, instrumentation and piping are estimated by applying in-house modular factors to the equipment costs. Costs for land acquisition, excavation of archaeological sites and provision of cattle crossing were used directly.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: COST	FACTOR: CAPITAL COST
INDICATORS: (7) OFF-SITE FACILITIES	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses all capital costs associated with the off-site facilities including utilities required to service the sites (water, natural gas, hydro, telephone, sanitary sewers and storm sewers), road upgrading/improvements from the 400 series highways to the candidate sites including the necessary land acquisition for access road improvement additional right-of-way and drainage improvements to the existing off-site drainage channels.	
RATIONALE/SIGNIFICANCE: The off-site facilities were identified in Phase 3 (Ref: OWMC²¹) and have been further developed during Phase 4A. They are required to service and access the OWMC Treatment Facility.	
SOURCES OF INFORMATION: The availability and location of utilities required to service the Facility were identified for each candidate site by the respective Regional/Municipal Authority.	
INPUTS FROM OTHER CONSULTANTS: In the case of non availability of Regional/Municipal storm sewer, discharge locations for storm water, using existing off-site drainage channels and associated costs for improving the drainage channels, where necessary, were identified by Gartner Lee Associates Limited (Ref: GLAL⁸). In respect of road upgrading/improvement, capital costs were developed by M.M. Dillon Ltd. (Ref: MMD¹⁷) In respect of land acquisition, costs were estimated by Graydon Rogers Appraisals Limited based on the road right-of-way requirements identified by M.M. Dillon Ltd. (Ref: MMD¹⁷).	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

STUDY AREA: The eight candidates sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹).

COMMENTS/ASSUMPTIONS/LIMITATIONS: The utility services to the Facility with the exception of electrical power are estimated in-house. The costs for electrical power connection to the candidate sites were obtained from Ontario Hydro or the local authorities. Costs for land acquisition, road up-grading/improvements and drainage channel improvements were used directly.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION		
LEAD CONSULTANT: MONENCO LIMITED		
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST	
FACILITY COMPONENTS AFFECTED: OWMC TREATMENT FACILITY		
FACTOR APPLIED FOR FOLLOWING OPTIONS:		
Access Roads No	Rail Access No	Refinement of Site Boundaries No
Location of Physical/Chemical Treatment Plant Yes	Siting Option Comparison Yes	Other None
DEFINITION OF FACTOR: The operating cost is the total estimated cost to operate OWMC's Treatment Facility for each year of its planned operating life.		
RATIONALE/SIGNIFICANCE OF FACTOR: This factor addresses the operating costs associated with locating an OWMC Treatment Facility at the siting options and quantifies the incremental operating cost differences between siting options.		
INTERPRETATION/METHODOLOGY: Operating costs will be estimated for 150 000 t/a and 300 000 t/a Facilities for each of the siting options and then pro rated for years 1 through 10 in accordance with the waste throughput of the Facility identified by OWMC. The accuracy of the estimate is judged to be in the order of plus 30%, minus 18%.		

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST
INDICATORS: (1) FIXED OPERATING COSTS	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the annual fixed operating costs associated with the OWMC Treatment Facility including general administration, taxes (municipal and business), insurance and maintenance.	
RATIONAL/SIGNIFICANCE: The fixed operating costs are the annual costs incurred by the operation of the OWMC Treatment Facility which are independent of the quantity of waste being treated.	
SOURCES OF INFORMATION: Historical and in-house data for similar types and sizes of Facilities.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The eight candidates sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹).	
COMMENTS/ASSUMPTIONS/LIMITATIONS: General Administration, taxes and insurance are estimated at 4% of total capital cost. Maintenance is estimated at 3% of total capital costs excluding landfill and land acquisition costs.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST
INDICATORS: (2) VARIABLE OPERATING COSTS	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the annual variable operating costs associated with the OWMC Treatment Facility including labour, utility services, additives and reagents, landfill operation (including additional cell construction, maintenance of landfill equipment, utilities and labour), transportation of special waste to the Facility from the waste generators, transportation of additives and reagents to the Facility from the nearest supplier and intersite transportation between partially integrated sites.	
RATIONALE/SIGNIFICANCE: The variable operating costs are the annual costs incurred by the operation of the OWMC Treatment Facility which are dependent on the quantity of waste being treated.	
SOURCES OF INFORMATION: In-house data and facility design developed in accordance with the design basis established for Phase 4A. Costs for utility services were provided by the particular utility servicing each of the candidate sites.	
INPUTS FROM OTHER CONSULTANTS: Costs for transportation were developed by M.M. Dillon Ltd. (Ref: MMD¹⁷).	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

STUDY AREA: The eight candidates sites identified in OWMC's Phase 3 Report, (Ref: OWMC²¹).

COMMENTS/ASSUMPTIONS/LIMITATIONS:

Operating Labour - An average annual labour cost has been developed from Statistics Canada's March 1984 Catalogue 72-002 Employment Earnings and Hours, including an allowance for fringe benefits of 11%.

Utilities:

- Electricity - Costs are based on 1984 Ontario Hydro or local Hydro Commission rates and include a demand charge based on an estimated installed capacity and energy charges based on power consumption forecasts assuming a specified operating pattern.
- Water, Sewer - Water supply and sewer surcharges are costed on the basis of rates supplied by the local municipalities. No charges are debited to the supply of raw water to sites not serviced by a municipal water supply.
- Natural Gas - 1984 industrial rates supplied from Provincial Gas and Union Gas.
- Fuel Oil - Fuel Oil has been estimated on the basis of using No. 2 oil with prices obtained from local suppliers.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

Additives and Reagents - Prices for additives and reagents, (including consumables) FOB suppliers plant, have been extracted from the Corpus Chemical Report, July 1984 or provided by quotations from major suppliers.

Engineered Landfill - Costs were estimated in-house covering the construction of two landfill cells, extending the delivery system, operation and maintenance of equipment specific to the landfilling, landfill operating labour, services and monitoring of the landfill performance.

Transportation - M.M. Dillon Ltd. (Ref: MMD¹⁷) developed a transportation scenario in concert with OWMC using the quantities of special waste, intersite transfers and additives and reagents developed by Monenco (See Tables 2.1, 2.2 (pp 46, 47) and Appendix C.1).

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST
INDICATORS: (3) START-UP COSTS	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the start-up costs associated with the initial start-up and for the facility expansion.	
RATIONALE/SIGNIFICANCE: The start-up costs are the costs associated with hiring and training of staff, initial marketing and advertising and an allowance to cover the initial operational adjustments during start-up.	
SOURCES OF INFORMATION: Historical and in-house data for similar types and sizes of Facilities.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The eight candidate sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹).	
COMMENTS/ASSUMPTIONS/LIMITATIONS: The start-up costs are estimated in-house. An allowance of \$3,600,000 for hiring and training of staff, initial marketing and advertising is incurred in year -1. The cost associated with initial operational adjustments for the 150 000 t/a Facility is incurred in year 1 and for the 300 000 t/a expanded Facility in year 6.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST
INDICATORS: (4) DECOMMISSIONING COSTS	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the costs associated with closing the OWMC Treatment Facility at the end of its useful life.	
RATIONALE/SIGNIFICANCE: The decommissioning costs are the costs associated with decontamination and disposal of all equipment, structures and surfaces, including contaminated soil, and restoring the land associated with the central operating area to its pre-facility condition.	
SOURCE OF INFORMATION: Historical and in-house data for similar types and sizes of Facilities.	
INPUTS FROM OTHER CONSULTANTS: None	
STUDY AREA: The eight candidate sites identified in OWMC's Phase 3 Report, (Ref: OWMC²¹).	
COMMENTS/ASSUMPTIONS/LIMITATIONS: Decommissioning costs, are estimated in-house and have not allowed any credit for possible salvage value of any of the equipment or structures.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: OPERATING COST
INDICATORS: (5) POST CLOSURE AND LONG TERM CARE	CONSULTANT: MONENCO LIMITED
DEFINITION: Post closure is a period following closure of the engineered landfill, in which continued monitoring will identify the long term requirements for the facility maintenance. Long term care is the period following post closure and includes: - ongoing monitoring, including surface and ground water monitoring, and - ongoing maintenance of landfill cover, leachate collection system and surface drainage system.	
RATIONALE/SIGNIFICANCE: Post closure and long term care are requirements identified in the MOE Blueprint Document.	
SOURCE OF INFORMATION: Historical and in-house data for similar types and sizes of Facilities.	
INPUTS FROM OTHER CONSULTANTS: None.	
STUDY AREA: The five candidate sites identified in OWMC's Phase 3 Report (Ref: OWMC²¹) which may be considered as suitable for an engineered landfill.	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

COMMENTS/ASSUMPTION/LIMITATIONS:

The annual costs for the ongoing monitoring and maintenance which starts in year 21 are included by means of an annuity type funding mechanism established in year 20.

Excluded from this indicator are:

- major renovations to the landfill covers or leachate collection system,
- leachate treatment (if the leachate system is actively operated and the leachate quality is such that it must be treated), and
- implementation of a contingency plan if required.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION		
LEAD CONSULTANT: MONENCO LIMITED		
FACTOR GROUPING: ENGINEERING	FACTOR: FLEXIBILITY	
FACILITY COMPONENTS AFFECTED: OWMC TREATMENT FACILITY		
FACTOR APPLIED FOR FOLLOWING OPTIONS:		
Access Roads No	Rail Access No	Refinement of Site Boundaries No
Location of Physical/Chemical Treatment Plant No	Siting Option Comparison No	Other Sensitivity Analysis
DEFINITION OF FACTOR: Engineering flexibility is an analysis of the ability of a siting option to accommodate potential changes occasioned by on-going development and optimization of design and layout.		
RATIONALE/SIGNIFICANCE OF FACTOR: This factor was introduced as part of the sensitivity analysis to address potential constraining features, other than those identified by the site selection team, which could significantly impact on the various options presently being considered by OWMC and on the freedom of the Engineer (Monenco Limited) to produce an optimal design.		
INTERPRETATION/METHODOLOGY: The design development of the Facility is proceeding in parallel with the Phase 4A site selection. Each siting option was examined to determine if there were any severe constraints in respect of: • Facility Design - selection of an alternative type of engineered landfill, and		

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

INTERPRETATION/METHODOLOGY (Cont'd)

- selection of a method of disposal of treated effluent from the physical/chemical treatment plant.
- Facility Layout - modifications to conceptual layout,
 - rail access for delivery of chemicals and reagents,
 - location of incinerator stack,
 - expansion of technical buffer zone, and
 - expansion of landfill area.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: FLEXIBILITY
INDICATORS: (1) FACILITY DESIGN	CONSULTANT: MONENCO LIMITED
DEFINITION: This indicator addresses the ability of the siting options to accommodate alternative landfill designs and effluent disposal options.	
RATIONALE/SIGNIFICANCE: OWMC have identified three general types of engineered landfill for the disposal of treated and solidified wastes, namely: • conventional • above ground, and • shallow entombed. OWMC identified five methods for the ultimate disposal of treated effluent from the physical/chemical treatment plant, namely: • evaporation with discharge of water vapour to atmosphere, • treatment in the solidification plant and disposal in the engineered landfill, • discharge via pipeline to a receiving water body (Lake Ontario or Lake Erie) or sewer system, • trucking to a receiving water body or sewer system, and • deep well injection.	
SOURCE OF INFORMATION: On-going design development of the Facility (Ref: MONENCO¹⁹ and OWMC²³).	
INPUTS FROM OTHER CONSULTANTS: Gartner Lee Associates Limited (Ref: GLAL⁷) identified sites which can potentially accommodate the various landfill design alternatives. The site selection team conducted an overview analysis of the effluent disposal options (Ref: MMD¹⁶).	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

STUDY AREA: The six siting options remaining after the elimination of site LF-2N and Case 3 (Incinerator Separate).

COMMENTS/ASSUMPTIONS/LIMITATIONS: During Phase 4B of the Facilities Development Process, site specific studies will be carried out for the preferred site(s) leading to the selection of a landfill design concept and an effluent disposal concept.

OWMC PHASE 4A - FACTORS FOR SITE SELECTION	
FACTOR GROUPING: ENGINEERING	FACTOR: FLEXIBILITY
INDICATORS: (2) LAYOUT	CONSULTANT: MONENCO LIMITED
DEFINITION: This factor addresses the ability of the siting options to accommodate alternative physical arrangements, orientations and buffer zone requirements, as well as opportunities for expansion of the engineered landfill.	
RATIONALE/SIGNIFICANCE: Two conceptual arrangements were developed for site specific conditions. In Phase 4B, as the design is being finalized and optimized, aspects requiring investigation include: • conceptual arrangement, • rail access for delivery of reagents and chemicals, • location of incinerator stack, • expansion of technical buffer zone, and • expansion of landfill area.	
SOURCE OF INFORMATION: On-going design development of the Facility.	
INPUTS FROM OTHER CONSULTANTS: The site selection team indicated that there was an opportunity for rail access to all sites except PI-13N (Ref: MMD¹⁶).	
STUDY AREA: The six siting options remaining after the elimination of LF-2N and Case 3 (Incinerator Separate).	

OWMC PHASE 4A - FACTORS FOR SITE SELECTION

COMMENTS/ASSUMPTIONS/LIMITATIONS:

- In respect of rail access, this is based on the assumption that rail service is not an absolute requirement for facility operations, but should be treated as an opportunity for the delivery of chemicals and reagents if it offered significant advantages in impacts and costs.
- The optimization of the design and layout may change the size of the operating area, which in turn may require modification to the extent of the 400 m technical buffer zone.
- Final selection of the type of engineered landfill and possible extension of the landfill life beyond 20 years may require additional land area.

APPENDIX B

INPUT TO RISK ASSESSMENT

APPENDIX B
INPUT TO RISK ASSESSMENT

INTRODUCTION

As minimizing the risk to human health is the highest ranked goal of OWMC in guiding the Facilities Development Process and, ultimately, in the construction and operation of the Facility, a generic risk assessment was undertaken by Environ Corporation as part of Phase 4A in order to provide a better understanding of the relative importance of siting factors related to human health risk (Ref: ENVIRON⁵). The generic risk assessment was designed to provide quantitative estimates of public health risks associated with the emission of toxic pollutants during the transportation, treatment and disposal of the special wastes. The term "generic" indicates the use of a single set of generalized site parameters applicable to all sites rather than the characteristics specific to each.

The generic risk assessment (Ref: ENVIRON⁵) considered risks on the following basis:

- Long term risks associated with normal facility operation and arising from either direct inhalation or ingestion via drinking water from ponds and cisterns as well as local crops, milk or beef.
- Short term risks associated with direct inhalation of emissions arising from process upset conditions or accidents.

Part B.1 of this Appendix "Preliminary Estimate of Gas Emissions for Risk Assessment" documents the engineering input to this generic risk assessment and summarizes the gaseous emissions associated with normal facility operation, upset conditions and potential on-site accidents.

Part B.2 of this Appendix, "Engineered Containment" provides a series of potential events which could result in spills or leaks in the central operating area of the Facility. This discussion provides the engineering input to the hydrogeologic assessment and basic acceptability analysis undertaken by Gartner Lee Associates Limited (Ref: GLAL⁷).

Input to the generic risk assessment on the potential hazards arising from transportation accidents or spills off-site has been provided by M.M. Dillon Limited (Ref: MMD¹⁷).

The methodology used in developing the engineering input was to examine normal operating scenarios, upset conditions and potential on-site accidents which were identified for evaluation of potential health risks in respect of stack emissions, fugitive emissions, spills and leaks. In each instance a conservative approach was adopted so that the assessment would not understate the risk.

APPENDIX B.1

PRELIMINARY ESTIMATE OF

GAS EMISSIONS FOR

RISK ASSESSMENT

PRELIMINARY ESTIMATE OF GAS EMISSIONS

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1.0 INTRODUCTION

This document is the engineering input to the generic risk assessment conducted as part of the Phase 4A site selection process.

Since, at this stage of the project, only a comparison of potential risks is needed (Ref: ENVIRON⁵), the emission scenarios analyzed here are only those which are believed to have an influence on the ranking of the various siting options and are thus not for assessment of the total risks. A more detailed risk analysis will be conducted once the actual site(s) has been selected and the design has progressed to a more advanced stage.

It should be noted that the emissions are described in terms of quantity, duration and, where applicable, frequency of occurrence. The following reports by other members of the site selection team should be consulted as to the risks and impacts associated with these emissions.

Site Selection Process. Phase 4A: Selection of Preferred Site(s)

- Agriculture (Ref: ECOL³)
 - Generic Risk Assessment (Ref: ENVIRON⁵)
 - Surface Water (Ref: GLAL⁸)
 - Transportation (Ref: MMD¹⁷)
 - Atmospheric Conditions (Ref: ORF²⁰)
- and

2.0 BASIS OF INFORMATION

The various operating scenarios and risk assessments are based upon the Facility described in the "Status Report - Facility Design" (Ref: MONENCO¹⁹). As this design is still in the development stage, the emission rates are based upon simplified models. If later analysis shows that a particular aspect is critical, it will be re-evaluated and, if necessary, design and/or operating strategy changed.

The emission scenarios are based upon the waste profile provided by OWMC, developed to establish the mode of shipment as shown in the attached Table B.1.1, adjusted to an ultimate plant capacity of 300 000 t/a. In translating the OWMC waste profile to Table B.1.1, assumptions, based on knowledge of the wastes, were made to categorize the shipment modes of the wastes, so that the approximate throughputs of systems handling different forms of wastes could be quantified. It is recognized, however, that initial operations will commence with facilities to handle only 150 000 t/a. The implications of installing, for example, only one incinerator rather than two, are also discussed.

Only the emission of hazardous gases from the operating areas are considered here; liquid effluents are not covered. All liquids from the operating areas will be contained within the plant and only released after necessary treatment and testing. Assessment of liquid leaks and spills are addressed in Appendix B.2.

All hydrocarbon gas emissions were calculated on the basis of a single reference gas. Environ Corporation used these data and OWMC waste data to make emission rate projections for other hazardous gases. Surrogate chemicals were then selected by Environ by evaluating both the emission rate and the toxicity of potential chemicals contained in the wastes (Ref: ENVIRON⁵).

Calculation outlines for the reference gas in different emission scenarios are given in Exhibit B.1.

TABLE B.1.1 ANALYSIS OF WASTE SURVEYS

WASTE GROUP	SHIPPED IN:	STREAM	TONNES/YR	DRUMS (excluding PCB)	
1. Organic Sludge & Still Bottoms	(a) Drums	1	4043	Organic pumpable	4606.1
	(b) Tankers	2	5497	Organic non-pumpable	1286.9
	(c) Containers	3	9347	Inorganic acidic	1515.8
2. Solvents & Organic Solutions	(a) Drums	4	47	Inorganic alkali & neutral	1553.8
	(b) Tankers	5	1389.5	Inorganic non-pumpable	862.5
3. Waste Oil, Grease	(a) Drums	6	19	Total Drums	= 9825
	(b) Tankers	7	623.5	Drums as % of total	= 6.53
4. Oil & Water Mixtures	(a) Drums	8	15	TANKER LOADS	
	(b) Tankers	9	485	Organic liquids/sludges	11292
5. Organic & Oily Residues	(a) Drums	10	262	Aqueous organic materials	3532.7
	(b) Tankers	11	3620.5	Acidic liquids/sludges	48818
	(c) Containers	12	35	Alkali & neutral materials	49386
6. Heavy Metal Solutions & Residuals	(a) Drums	13	2644		113028
	(b) Tankers	14	85510	CONTAINER LOADS	
7. Miscellaneous Chemicals & Products	(a) Drums	15	542	Organic materials	9540
	(b) Tankers	16	106.5	Inorganic materials	18079
	(c) Containers	17	157.5		27619
8. Paints & Organic Residuals	(a) Drums	18	93	Note: This table only used for estimating waste handling requirements for different modes of shipment and includes a more conservative drum shipment rate.	
	(b) Tankers	19	3004.5		
9. Aqueous Solutions with Organics	(a) Drums	20	187		
	(b) Tankers	21	63		
10. Anion Complexes	(a) Drums	22	38		
	(b) Tankers	23	568		
	(c) Containers	24	194		
11. Sludges & Inorganic Residual	(a) Drums	25	1250		
	(b) Tankers	26	12125		
	(c) Containers	27	16625		
12. Pesticides & Herbicides	(a) Drums	28	36		
	(b) Tankers	29	35		
13. PCB Wastes	(a) Drums	30	35		
14. Clean-up Residues	(a) Drums	31	649		
	(b) Containers	32	1260		
Total amended waste =			150506	Source: Project Design Basis for Waste Unloading System.	

3.0 EMISSION SCENARIOS

Emission scenarios have been developed for the following types of facility operating scenarios:

- (a) Residual fugitive emissions under normal operating conditions.
- (b) Controlled emissions from the incinerator stack flue(s) during operation at the facility's ultimate capacity (ie. two incinerators).
- (c) Process upset conditions which can be anticipated, based on our knowledge from similar types of plant.
- (d) Potential accidents, including operational errors.

For risk and impact assessment purposes (a) and (b) are considered long term conditions while (c) and (d) are short term.

Fugitive emissions in the Facility are generally recovered or captured by adsorption/scrubbing within the ventilation systems which normally remove nearly all contaminants. The removal efficiency depends on the properties of the contaminant and, for site selection purposes, it has been conservatively assumed to be 90%.

Different areas of the Facility were analysed for the various categories of emissions. The scenarios which were judged to have a major influence on risk assessment are summarized in Table B.1.2, which also references descriptions of the events.

Brief descriptions of the identified emission scenarios by process area are then provided, together with estimated emission rates, durations and, where appropriate, frequency of occurrence.

Some of the scenarios were not analysed in detail because they were either considered to be of only minor significance in the overall emission scenario, there was insufficient data available to make a proper assessment at this stage, or the work had been done by other consultants. Some of these scenarios will require updating as the design progresses to a more advanced state.

The locations of the various emission sources can be identified by reference to the "Layout of Operating Area" and "Site Layout" figures included in Appendix D. Where possible, the height of the emission source above ground level is indicated in each description.

TABLE B.1.2

GAS EMISSION SCENARIOS

NORMAL OPERATION	OFF-SITE	WASTE HANDLING	WASTE STORAGE	PHYSICAL/CHEMICAL TREATMENT AND SOLIDIFICATION PLANT	INCINERATION PLANT
	Transportation (Ref: MMD 17)	Unloading Bays Tank Vents: • Organic (5.1.1) • Inorganic (5.4.1) Drum Handling (5.3.1) Incinerator Receiving Tanks (5.2.1)	Incinerator Tank Farm Vents (6.1.1) Physical/Chemical Tank Storage Vents (6.2.1)	Oxidation/Reduction Reactors (7.1.1) Precipitation Reactors (7.2.1) Reagent Preparation (7.3.1) Dissolved Air Floatation (7.4.1) Emulsion Breaker (7.5.1) Cement Silo (7.6.1)	Bunker Vent (4.2.1.1) Stack (8.1.1)
UPSET CONDITIONS		Unloading Bays Tank Vents: • Organic (5.1.2) • Inorganic (5.4.2) Drum Handling (5.3.2)		Oxidation/Reduction pH Monitor Failure (7.1.2) Precipitation Reactor pH Monitor Failure (7.2.2)	Scrubber Failure (8.1.2)
ACCIDENTS	Spillage (Ref: MMD 17)		Incinerator Tank Farm Fire (6.1.2) Mixing Incompatible Wastes (6.2.2)		

4.0 EMISSION SOURCES

The gas emissions scenarios listed in Table B.1.2 have been classified into source areas which are described in this section. These areas are examined individually in respect to type and quantity of emission. Table B.1.3 lists the source areas and the control systems used to contain and reduce emissions to the atmosphere.

4.1 RESIDUAL FUGITIVE EMISSIONS

Residual fugitive emissions are vapours originating from any source within the facility e.g. open drums. These vapours are captured, treated and discharged through the ventilation systems.

4.1.1 WASTE HANDLING

4.1.1.1 General

Wastes will be unloaded at one of several locations throughout the Facility depending upon the type and consistency of the waste.

The Unloading Bays will be used to receive both organic and inorganic wastes arriving in bulk road haulage vehicles. They will also be used to receive and to separate mixtures of pumpable wastes containing quantities of gross solids.

The Drum Storage and Handling building is designed to accept all types and forms of waste arriving in drums of up to 200L size.

TABLE B.1.3

EMISSION CONTROL SYSTEMS

SOURCE AREA	EMISSION CONTROL SYSTEM
<u>WASTE HANDLING</u>	
Unloading Bays and Receiving Tanks:	
• Organic Waste Unloading Tanks	Vent through gas scrubber/activated carbon adsorber.
• Inorganic Waste Unloading Tanks	Vent through gas scrubber/activated carbon adsorber.
• Incinerator Receiving Tanks	Combined with Incinerator Tank Farm. Nitrogen blanket pressure system vented to incinerator air intake. If incinerator unavailable, vent through activated carbon adsorber.
Drum Handling:	
• Vacuum Tanks	Blanketed with Nitrogen Vent to incinerator air intake. If incinerator unavailable, vent through activated carbon adsorber.
• Fume Extraction	Vent through activated carbon adsorber.
<u>WASTE STORAGE</u>	
Incinerator Tank Farm	Nitrogen blanket pressure system vented to incinerator air intake. If incinerator unavailable, vent through activated carbon adsorber.
Physical/Chemical Tank Storage	Vent through gas scrubber/activated carbon adsorber.
<u>PHYSICAL/CHEMICAL TREATMENT AND SOLIDIFICATION PLANT</u>	
Reactors	Vent through gas scrubber/activated carbon adsorber.
Sodium Sulphide Preparation	Vent through gas scrubber/activated carbon adsorber.
Dissolved Air Floatation and Emulsion Breaker	Vent through activated carbon adsorber.
<u>INCINERATION PLANT</u>	
Stack	Flue gas treatment system.

Dry bulk organic wastes arriving in bulk containers or dump trucks will be unloaded directly into the Incinerator Bunker.

Non-pumpable bulk inorganic wastes not requiring physical/chemical treatment will be unloaded at the Solidification Plant.

4.1.1.2 Unloading Bays and Receiving Tanks

This part of the plant will contain, for the initial plant throughput (150 000 t/a), thirteen (13) truck unloading stations, nine (9) of which will be designated to handle inorganic wastes and the remaining four (4) organic wastes. Additional stations will be added when the plant is expanded to a throughput of 300 000 t/a.

Generally, pumpable organic wastes will be unloaded by pumping the contents of the tank truck directly into a receiving tank or to one of the storage tanks in the incinerator tank farm. This will be accomplished by connecting a flexible hose between the outlet valve of the tank truck and the suction of an unloading pump. Based on operational judgement, on completion of the transfer, the interior of the tank truck may be visually inspected and any residual waste flushed to the outlet with a water hose. This material will also be pumped out.

Each of the nine inorganic unloading stations and two of the four organic unloading stations will be provided with below-ground unloading tanks containing a removable screened cage. In the event that waste, which would otherwise be pumpable but in fact contains gross solids, has to be separated, then the shipment will be unloaded into the tank through the cage. Solid materials will be retained by the cage and will be transferred to drums or a container. The pumpable waste will be pumped to storage. Similarly, semi-pumpable waste or dry waste which can be readily slurried will be unloaded into the unloading tanks (reception basins) and converted

into a pumpable slurry by the addition of water (or other compatible liquid).

All below-ground unloading tanks (reception basins) will be equipped with covers or gates, and an extraction fan connected to a vent exhaust system. Separate exhaust systems will be provided for the organic and inorganic unloading tanks. Each extraction fan will be designed to maintain a negative pressure in the tanks when the gates are closed, and an air velocity of about 0.3 m/s through the tank opening when the gates are open. The exhausts of the extraction fans will be ducted to a scrubber/adsorber system before venting to the atmosphere.

All four organic unloading stations will have an intermediate receiving tank into which the waste will be pumped before being transferred to the incinerator tank farm. Each receiving tank will be vented to a vent exhaust system common to the organic storage tanks in the incinerator tank farm.

4.1.1.3 Drum Storage and Handling Building

The Drum Storage and Handling Building will be designed to accept wastes of all types which may arrive in drums up to 200 L in size. Drums containing pumpable wastes will be opened by either removing the lid or the screwed filling hole plug (failing this, a hole will be cut in the drum top), and the contents transferred to a receiving tank. Several similar facilities will be provided so that more than one drum can be unloaded at a time, with the unloading of organic and inorganic wastes being strictly segregated. It is anticipated that 4 drum unloading stations will be needed for both organic and inorganic wastes, although, in order to handle peak demand rates, up to 8 may be needed for the ultimate plant capacity. Vapour escaping from opened drums will be collected by the ventilation system which exhausts the air through a carbon adsorber system.

The drum unloading stations will be essentially the same, consisting of a vacuum receiver, a suction pipe, a vacuum pump and a transfer pump. The operation will consist of establishing and maintaining a vacuum in the vacuum receiver, and then manually inserting the suction pipe into each drum as it enters the unloading station. A manually operated valve located in the suction pipe will be used to start and stop the unloading operation. When the vacuum receiver becomes full, or the last drum of a particular batch has been emptied, the contents of the receiver will be pumped to a holding tank or a blending tank according to the schedule established for the particular waste. A nitrogen blanket will be provided for each organic vacuum receiver, so that as the liquid is being transferred out, a non-explosive atmosphere will blanket the system at all times.

Each vacuum pump will exhaust to a common header which will vent to the incinerator. If the incinerator is not available eg. being down for maintenance, the exhaust will be vented to the atmosphere through an activated carbon adsorber/scrubber system.

Drums containing non-pumpable wastes will also be opened, or the top cut off. In order to reduce thermal surges in the incinerator, very full drums may be partially emptied into empty drums. Drums containing solid organic wastes will be sent to the Incinerator where the drum and its contents will be incinerated. Drums containing solid inorganic wastes will be sent to the Physical/Chemical Treatment and Solidification Plants for further treatment.

4.1.2 WASTE STORAGE

The Waste Storage includes the tank storage areas for the incineration plant and the physical/chemical treatment plant. They will be used to perform the following functions:

- Storage, blending and pre-treatment of pumpable wastes received from waste generators and from on-site waste sources.
- Storage of supplementary fuels.

The Waste Storage will consist of two storage areas:

- Incinerator tank farm for organic wastes, aqueous organic wastes, and supplementary fuels.
- Physical/chemical tanks storage for mostly inorganic wastes.

4.1.3 PHYSICAL/CHEMICAL TREATMENT AND SOLIDIFICATION PLANTS

The physical/chemical treatment and solidification plant will contain the following equipment used in the treatment of inorganic wastes that could be a source of emissions:

- oxidation/reduction reactors for the oxidation of cyanides and reduction of chromium,
- neutralization/precipitation reactors for heavy metals removal,
- emulsion breaker and dissolved air flotation unit to separate hydrocarbon/water emulsion,

- reagent preparation, and
- cement silos for storage of solidification reagent.

4.2 CONTROLLED EMISSIONS

In the incineration plant, the stack is considered a source of controlled emissions.

Controlled emissions are gases with suspended particulates, which are passed through the flue gas treatment system and discharged from the incineration plant stack.

4.2.1 INCINERATION PLANT

4.2.1.1 Incinerator Bunker

The bunker is intended only for dry organic wastes and hence should not result in emissions. Although the bunker could possibly receive some "not-so-dry" wastes, such as free moisture in the waste which could settle out and/or have significant organic volatility, to cater for this situation, the bunker will be ventilated by the induced air flow of the incinerator combustion air fan.

4.2.1.2 Stack

The flue gas treatment system, as described in the "Status Report - Facility Design" (Ref: MONENCO 19), consists of a spray dryer, an

electrostatic precipitator and a three stage wet gas scrubber to clean the incinerator flue gas prior to being discharged to the atmosphere, via the stack. On leaving the scrubber the gases pas through a mist eliminator and are reheated before discharge from the stack.

5.0 WASTE HANDLING

5.1 ORGANIC WASTE UNLOADING TANKS

5.1.1 NORMAL OPERATION

Based on 300 000 t/a of special waste being received in the same mix as shown in Table B.1.1 (p. B.1-3), it was conservatively estimated that up to 22 600 t/a of organic waste could be in liquid/sludge form. As a "worst case", it was assumed that all of this material will be unloaded via the waste unloading tanks (reception basins) and that unloading will be accomplished by opening the basin gate (area 2 m²). In normal practice, many shipments will be unloaded using hoses through a smaller access opening in the gate. Pumpable sludge will preferably be pumped directly to the storage tank rather than unloaded through the reception basins, for both safety and emission considerations.

When both incinerators are in normal operation (at 7000 hours per year each) but on a staggered shutdown basis, shipments of organic waste can be received throughout 52 weeks per year and 5 days/week, giving 260 possible shipping days. On the other hand, if only one incinerator is installed, fewer shipping days can be accommodated without using up surplus storage capacity in the incinerator tank farm. Therefore even with two incinerators, the number of shipping days will probably be less than 260 if periods of simultaneous shutdown occur. Assuming 250 working days per year, and approximately 15 tonnes per shipment, an average of 6 shipments per working day will be received.

The emission of hydrocarbons to the atmosphere from the unloading stations was estimated using the volume of air displaced during a 15-minute unloading period, an average of 20% saturation of hydrocarbons in the vented air, the vapour pressure of toluene at 10°C (mean annual temperature) as a reference hydrocarbon and a removal efficiency of 90% for the adsorber scrubber system. This calculation gave a rate of approximately 1.08 Nm³ per 8 hour working day or 270 Nm³/a at a vent height of about 9 m above ground level (See Exhibit B.1, Calculation #1, p. B.1-37).

At the peak unloading rate for the three organic unloading stations (ultimate capacity) which have below-grade waste unloading tanks, the number of shipments per working day could be 20. The corresponding emission of organic vapour (based on toluene at 10°C) would be approximately 3.6 Nm³/day. Emissions of other organic chemicals can readily be estimated using the appropriate vapour pressure.

5.1.2 UPSET CONDITION - VENT SYSTEM FAILURE

Occasionally, it can be expected that the activated carbon adsorber on the vent system will be inactive for a short period of time.

For each shipment of (toluene based) organic waste unloaded via the waste unloading tanks (reception basins) when the adsorber is inactive, the hydrocarbon emission is estimated to be 7.3 kg over the approximate 15 minute period that the basin is opened, (See Exhibit B.1 Calculation #1 p. B.1-37).

5.2 INCINERATOR RECEIVING TANKS

5.2.1 NORMAL OPERATION

As these four tanks are being filled, they will expel nitrogen which, under the worst conditions, will be saturated with hydrocarbon vapour. However, the vents from these tanks are connected into the vent system of the storage tanks in the incinerator tank farm and are handled along with emissions from this area (see Section 6.1.1 p. B.1-22).

5.3 DRUM HANDLING

5.3.1 NORMAL OPERATION

From Table B.1.1 (p. B.1-3), it can be seen that approximately 5 000 t/a of pumpable organic waste in drums may be expected. For the 300 000 t/a rate, 10 000 t/a can be expected, corresponding to about 50 000 drums. Assuming approximately 250 working days per year but only one shift per day, it is estimated that 4 unloading stations will be required to be in simultaneous operation.

Each unloading station will consist of a 16 m³ receiving tank and a vacuum pump. All vacuum pumps will normally exhaust into the incinerator and hence will result in no emissions of organic vapour. During periods when both incinerators are out of service, the vacuum pumps will exhaust to the atmosphere through an activated carbon adsorber, although at this time, unloading activities are expected to be minimized.

The daily cycle of operations will consist of establishing a vacuum in the receiver, unloading approximately 50 drums of liquid into the receiver and finally releasing the vacuum with nitrogen, as the liquid is being pumped out. Loss of hydrocarbon vapour will occur during:

- (a) drum opening and waiting on conveyor,
- (b) initial evacuation of the receiving tank,
- (c) maintenance of the vacuum due to air infiltration,
- (d) displacement of vapour as the receiver is filled.

For item (a), this loss of hydrocarbon will occur via the fume hood ventilation system which will contain an activated carbon adsorber. It is assumed that normally about 20 drums will be open at a time for a continuous period of 7 hours/day, 5 days/week and 50 weeks/year.

Total toluene vapour lost was estimated to be $2.37 \text{ Nm}^3/\text{day}$ as shown in Exhibit B.1 Calculation #4 (p. B.1-42).

Assuming activated carbon has an efficiency of 90%, the emissions will amount to approximately $0.24 \text{ Nm}^3/\text{day}$, and are discharged at about 10.5 m above ground level. Air flow from the organic drum handling area will be $6.97 \text{ m}^3/\text{s}$ to achieve a vent velocity of 10.26 m/s.

At the peak unloading rate, when all eight unloading stations are in use, it is possible that up to 40 drums may be open at a time and that the volume of toluene vapour lost into the fume extraction system will be $0.00019 \text{ Nm}^3/\text{s}$. However, the activated carbon adsorber is expected to catch 90% of this hydrocarbon leaving an emission to the atmosphere of $0.000019 \text{ Nm}^3/\text{s}$.

Since it will be a policy to minimize drum unloading during periods when no incinerator is available, the case of using eight unloading stations at this time will not occur.

During actual plant operation, complete removal of a drum top will be minimized, and if it has to be done, the opened drums will be covered with temporary barriers. The above estimate of the total open drums is intended to be conservative.

For items (b), (c) and (d), the losses will normally be directed to the air intake of the incinerator where they will be burned. If both incinerators are out of service simultaneously, or if only one incinerator is built (for 150 000 t/a Facility), the gases will be vented to the atmosphere through an activated carbon adsorber.

The estimated emissions for these three items are as follows, conservatively assuming that the air removed from each station is saturated:

<u>Cause</u>		<u>Toluene lost per station</u> <u>(Nm³/day)</u>	
Initial evacuation		0.27	
Vacuum	maintenance	7	hrs/day
	x 0.173 =	1.21	
Displacement of vapour		0.46	
		1.94	
Total for 4 stations =		7.76 Nm ³ /day	

Outlines of calculations for these causes are given in Exhibit B.1 Calculation #5, (p. B.1-44).

During the initial operations when only 150 000 t/a of waste is processed, and only one incinerator is installed, the quantity of toluene lost will be proportionately less. However, the period during which the activated carbon adsorber is in use could be longer than when two incinerators are available.

One incinerator is expected to operate 7 000 hours/year, and hence with two installed, the activated carbon system is not expected to be required except for emergencies. During initial operation when only one incinerator is installed, but is not available, the activated carbon system must be used.

Period of year required = 1 760 hours or 73.3 days
= 10 weeks and 3.3 days.

The drum unloading is assumed to occur 5 days/week and up to 50 weeks/year. It is reasonable to assume that the remaining 2 weeks of the year coincide with the 10 weeks in which the incinerator is also shutdown. Therefore, period of use of activated carbon system could be

8 weeks x 5 days/week + 3.3 days
= 43.3 days.

If the activated carbon adsorber has an efficiency of 90%, the emission of toluene to the atmosphere will be 0.388 Nm³/ day (for the 150 000 t/a Facility), and is expected to occur about 10.5 m above ground level through the exhaust of the adsorber of the fume hood ventilation system.

5.3.2 UPSET CONDITION - VENT SYSTEM FAILURE

Occasionally the activated carbon adsorber could be inactive, the hydrocarbon emission for the gases which are treated by the adsorber will increase accordingly as calculated above.

5.4 INORGANIC WASTE UNLOADING TANKS

5.4.1 NORMAL OPERATION

Based on the reception of 300 000 t/a of special waste being received in the same mix as shown in Table B.1.1 (p. B.1-3), it may be expected that approximately 1600 t/a of cyanide bearing waste (waste group 10) will be received. Assuming 16 tonnes/shipment, this amounts to 100 shipments per year. As a "worst case", it is assumed that all of this material must be unloaded into the inorganic waste unloading tanks (reception basins) and then transferred to storage.

It is estimated that HCN emissions amounting to $0.0114 \text{ Nm}^3/\text{a}$ would result from this activity, at approximately 9 m above ground level. This estimate is based on a total concentration of cyanide in slurry of 10 g/L expressed as cyanide ion, which is probably the upper end of the cyanide concentration range in the raw wastes, a pH of 9.5, and a scrubber adsorber removal efficiency of 90% (See Exhibit B.1 Calculation #3 p. B.1-40).

5.4.2 UPSET CONDITION - VENT SYSTEM FAILURE

Failure of the scrubber/adsorber on the ventilation system for these unloading tanks (reception basins) would result in HCN emissions of $0.00114 \text{ Nm}^3/\text{shipment}$ over an approximate 15 minute period.

6.0 WASTE STORAGE

6.1 INCINERATOR TANK FARM

6.1.1 NORMAL OPERATION

Using the analysis of waste surveys in Table B.1.1 (p. B.1-3), the total quantities of pumpable organic wastes (including shipment in drums) expected at the 300 000 t/a plant throughput are:

organic liquids & sludges	31 800 t/a
aqueous organics	<u>7 065 t/a</u>
	38 865 t/a

For the purposes of these calculations, all of this waste is assumed to be delivered in tank trucks and the reference hydrocarbon is taken to be toluene for both types of waste. The delivery schedule is assumed to be uniform over a 7 hour period each day, 5 days per week and 52 weeks per year. This reduces to a daily receipt of approximately 150 m³, corresponding to about 10 bulk shipments (15 m³ each) per day. In the incinerator tank farm, a corresponding volume of hydrocarbon-laden gas must be displaced from the storage vessels. The design of the vent gas system is such that, where possible, gas displaced from one tank will be routed to another tank which is being emptied through a common vent system. The vent system is controlled within a range of positive pressure with nitrogen and also covers the organic waste receiving tanks located at the unloading stations and storage for organic containing wastes in the Physical/Chemical tank storage. When the vent system pressure is too high, the gas will be routed to the incinerator and the hydrocarbons will be burned. In the event that both incinerators are out of service at the same time, or if the single incinerator (for the 150 000 t/a Facility) is not available, the gases will be vented to the atmosphere through an activated carbon adsorber.

One incinerator is expected to operate 7 000 hours/year, and hence with two available, the activated carbon system is not expected to be used except for emergencies. In these unlikely circumstances, the emission of organic vapour to the atmosphere (based on toluene) would be no more than about 0.25 Nm³/day, (See Exhibit B.1 Calculation #2 p. B.1-38), and is expected to occur at about 9 m above ground level. The vent gas velocity will vary depending on the liquid displacement rate.

For the initial 150 000 t/a Facility, when the single incinerator is not available, the activated carbon system will be used although only half the quantity of vapour will be treated and thus the emission of (toluene equivalent) vapour is not expected to exceed 0.13 Nm³/day.

Period of year required = 8 760 - 7 000 = 1 760 hours
= 10 weeks and 3.3 days

Unloading of wastes is assumed to occur 5 days per week, hence the total number of days/year during which the system will be in use will be 53.3 days.

At the maximum instantaneous loading rate of 70 L/s, and assuming as a worst case that the pressure in the tank vent system has reached its upper limit of 169 kPa, then the instantaneous release rate of (toluene)vapour from the vent system will be 0.0011 Nm³/s. If the vapours cannot be vented into the incinerator then, after the carbon adsorber, a release rate of about 0.00011 Nm³/s will occur as shown in Exhibit B.1 Calculation #2 (p. B.1-38).

6.1.2 ACCIDENT - INCINERATOR TANK FARM FIRE

Fire in the incinerator tank farm where 1,1,1 - trichloroethane is stored could cause emission of the organic vapor. This topic has been covered by

M.M. Dillon's report "Site Selection Process. Phase 3B: Selection of Candidate Site(s) Facilities Characteristics and Technical Buffer Zone" (Ref: MMD15)

The current incinerator tank farm design provides storage tanks of 10m^3 size for halogenated organic waste, which is the basis used by M.M. Dillon (Ref: MMD15). These storage tanks are internally nitrogen blanketed, segregated by dykes and provided with firewater monitors and a foam system for fire protection. With these safety features, a fire, although unlikely, is possible. This scenario, therefore, was included in the generic risk assessment. As a result of the assessment, further safety features (such as insulating the tank to reduce release rate during fire) may be added to minimize possible risks, if necessary.

6.2 PHYSICAL/CHEMICAL TANK STORAGE

6.2.1 NORMAL OPERATION

Based on Table B.1.1 (p. B.1-3), the quantity of cyanide bearing waste (waste group - 10) expected at the 300 000 t/a level is about 1 600 t/a or approximately $1\,500\text{ m}^3/\text{a}$.

The concentration of HCN in equilibrium with a solution of 1000 mg of CN^- per litre at pH 9.5 is about 2.3 ppm. Hence the quantity of HCN expelled from these storage tanks due to volume displacement.

$$\begin{aligned} &= 1\,500 \times 2.3 \times 10^{-6} \\ &= 0.0035\text{ m}^3/\text{a} \text{ (at say } 10^\circ\text{C)} \\ &= 0.0033\text{ Nm}^3/\text{a} \end{aligned}$$

Concentration of HCN vapour in equilibrium with a 10 g/L CN^- is slightly higher.

Considering that a water scrubber is expected to remove about 90% of this gas, the final HCN emission will be negligible. The gas will be vented through a common vent system shared with physical/chemical process reactors and ventilation hoods. Vent height will be at the building roof level of approximately 25 m and the airflow will be designed to be approximately 4.71 m³/s with a vent velocity of 10.26 m/s.

6.2.2 ACCIDENT - MIXING OF INCOMPATIBLE WASTE

The accidental mixing of incompatible wastes, such as sulphides or cyanides with a dilute acid, could release large quantities of toxic gases. The topic is described in M.M. Dillon's report "Site Selection Process Phase 3B: Selection of Candidate Sites. Facilities Characteristics and Technical Buffer Zone" (Ref: MMD¹⁵). This type of accident is unlikely to occur with the proposed monitoring instrumentation and data management systems. This scenario has, therefore, been included in the generic risk assessment.

7.0 PHYSICAL/CHEMICAL TREATMENT PLANT

7.1 CYANIDE OXIDATION REACTORS

7.1.1 NORMAL OPERATION

Based upon the waste quantities in Table B.1.1, the quantity of cyanide bearing waste expected at the 300 000 t/a level is about 1 600 t/a. It was conservatively assumed that the average concentration of cyanide will be about 1% and that it will be treated in 40 m³ batches at a concentration of 1 000 mg/L of CN⁻.

1 600 t/a at 1% by wt CN = 16 t/a of CN⁻

At 1 000 mg/L of CN⁻, total volume = 16 000 m³

Hence number of batches/year = 400 or 8 per week.

Treatment of a batch will consist of adding an oxidizing agent such as hypochlorite or hydrogen peroxide. The quantity of agent and length of treatment will depend upon treatability tests done on the particular waste.

For the purposes of illustration, the following typical batch sequence is given, with supporting calculations in Exhibit B.1 Calculation #6 (p. B.1-46):

pH = 9.5, reaction time = 6 hours

Temperature = 60°C, which is conservative.

Final CN⁻ concentration in liquid and vapour is zero.

Initial HCN vapour in equilibrium with liquid = 15 ppm

Average concentration over 6 hour period = 7.5 ppm

Assumed air infiltration due to vacuum in vent system and leaking manhole cover = 0.5 m³/min.

$$\begin{aligned}
 \text{Therefore, HCN exhausted} &= 0.5 \times 60 \times 6 \times 7.5 \times 10^{-6} \\
 &= 0.00135 \text{ m}^3 \text{ (at } 60^\circ\text{C) per batch} \\
 &= 0.0011 \text{ Nm}^3/\text{batch}
 \end{aligned}$$

This HCN laden air will pass through a water scrubber in which an assumed 90% will be absorbed. Therefore, emission will amount to about $0.00011 \text{ Nm}^3/\text{batch}$, and will occur at a height of about 25 m above ground level.

7.1.2 UPSET CONDITION - pH MONITOR FAILURE

This scenario assumes that the pH monitoring system is malfunctioning and that instead of a normal pH of 9.5, the actual pH is about 7.5.

Under this unlikely situation the initial HCN vapour in equilibrium with the solution would have a concentration of about 717 ppm. (See Exhibit B.1 Calculation #6 p. B.1-46).

$$\begin{aligned}
 &\text{HCN lost from reactor per batch} \\
 &= 0.5 \times 60 \times 6 \times \frac{(717-0)}{2} \times 10^{-6} \\
 &= 0.0645 \text{ m}^3 \text{ (at } 60^\circ\text{C)} \\
 &\text{or } 0.053 \text{ Nm}^3
 \end{aligned}$$

At 90% absorption efficiency, emission = $0.0053 \text{ Nm}^3/\text{batch}$

7.2 HEAVY METALS PRECIPITATION REACTORS

7.2.1 NORMAL OPERATION

The removal of heavy metals from waste solutions will be accomplished by the addition of sodium sulphide solution to a batch of the waste. When this is done in the alkaline state, it results in the precipitation of the

heavy metal as a sulphide. In the event that the pH is allowed to go to the acidic side, some hydrogen sulphide (H_2S) will be formed and will escape from the reactor.

It is assumed that normal operation of the precipitation reactor will occur at a pH value of 9.5. For those wastes having a pH value less than 9.5, sufficient caustic soda solution will be added to the batch to bring the pH to this correct value before any sulphide reagent is added. As can be seen from the following table, the mole fraction of H_2S in equilibrium with a sulphide solution at pH 9.5 is about 4 parts per billion. Using the same assumed air flow as for the Cyanide Oxidation Reactor, i.e. $0.5 \text{ m}^3/\text{min}$ for, say 1 hour, the H_2S emitted would be about $0.125 \times 10^{-6} \text{ m}^3$. Considering that this air will pass through a water scrubber before being vented to the atmosphere, it can be concluded that the H_2S emission will be negligible.

pH	9.5
Mole fraction H_2S in solution	2.34×10^{-10}
Vapour pressure @ 20°C (mm Hg)	1.34×10^4
Mole fraction H_2S in vapour (approximate only)	4.18×10^{-9}

7.2.2 UPSET CONDITION - pH MONITOR FAILURE

This case assumes that for one reason or another the pH value of the solution in the reactor falls from its normal of 9.5 to 5. The H₂S situation in the reactor then becomes:

pH	5.0
Mole fraction H ₂ S in solution	24.5×10^{-6}
Vapour pressure @ 20°C (mm Hg)	1.36×10^4
Mole fraction H ₂ S (approximate only)	438×10^{-6}

From the above table, the concentration of H₂S in equilibrium with the solution will be considerably higher than at a pH of 9.5. Again, using the figure of 0.5 m³/min as the air infiltration rate over a 1 hour period, the H₂S emitted to the vent system will amount to about 0.013 Nm³. After passing through a water scrubber with an efficiency of 90%, the emission would amount to about 0.0013 Nm³ over a 1 hour period, at a point about 25 m above ground level.

7.3 SODIUM SULPHIDE REAGENT PREPARATION

7.3.1 NORMAL OPERATION

In order to precipitate heavy metals, a 10% by weight solution of sodium sulphide will be mixed with the incoming waste in an agitated precipitation tank. This sodium sulphide solution will be prepared in a separate reagent storage tank by adding sodium hydrosulphide (NaHS), in the form of a 45 wt% solution in water, to a quantity of dilute caustic soda solution.

The potential for hydrogen sulphide (H_2S) emissions is present with any solution of sodium sulphide depending upon its pH value. A supplier of the NaHS (Stauffer Chemicals), however, claims that the 45% solution has been sufficiently buffered that dilution down to a 10% solution, even in the absence of caustic soda, will result in an equilibrium vapour concentration of less than 1 ppm.

It is, therefore, concluded that there will be no significant risk of H_2S emissions to the atmosphere even in the unlikely event that the caustic soda is omitted from the batch.

7.4 DISSOLVED AIR FLOTATION UNIT

7.4.1 NORMAL OPERATION

This unit subjects a batch of aqueous waste to air under pressure, at which time some of the air dissolves in the waste. Subsequent release of the pressure causes the dissolved air to come out of solution. As the air bubbles rise to the surface of the liquid they will carry with them small globules of hydrocarbons which otherwise would remain in suspension. The end result is that liquid hydrocarbon will tend to collect on the surface of the aqueous waste where, due to the action of the air, a layer of froth will be formed. It is therefore reasonable to assume that the air leaving the unit will approach saturation with respect to the hydrocarbon at the operating temperature.

Using toluene as the reference hydrocarbon, and $25^{\circ}C$ as the process operating temperature:

Vapour pressure = 30 mm Hg

Final operating pressure after gas release = 760 mm Hg

Volume fraction of toluene = 30/760

Estimated air volume = 0.006 Nm³/min

Volume of toluene vapour released before adsorber/scrubber system is
 $0.006 \times 30/760 = 0.000237 \text{ Nm}^3/\text{min}$

This emission can be assumed to be continuous and after passing through the 90% contaminant removal system, will be vented at a height of about 25 m above ground level. Upon occasional failure of the vent system the emission will increase accordingly.

Other Chemical Species

Emissions of other organic chemicals can be determined by using the above method and the appropriate vapour pressure.

7.5 EMULSION BREAKER

7.5.1 NORMAL OPERATION

The emulsion breaker tank has a volume of 32 m³ and is operated in a batch mode by filling with 25 m³ batches of oil/water emulsion. Heating to 70°C assists the breakdown of the emulsion. Filling of the vessel is accomplished in 15 minutes whereas draining the tank is expected to take about 2 hours. Therefore, it is reasonable to assume that the air space above the liquid attains saturation but that no condensation takes place during the subsequent filling operation. Hence the worst case is that 25 m³ of air, saturated with water vapour and organics at 70°C, is expelled from the vessel at each refilling operation.

Using toluene as the reference hydrocarbon:

vapour pressure @ 70°C = 200 mm Hg

vapour displacement = 25 m³ at 70°C or
19.9 Nm³

volume of toluene = 19.9 x 200/760
= 5.24 Nm³ over a 15 minute period

This would be released through the adsorber/scrubber system which removes more than 90% of the contaminants and discharged through the vent system at a height of about 25 m above the ground.

At the ultimate plant capacity of 300 000 t/a the probable quantity of emulsion will be 20 000 t/a or 80 t/day. Hence about 4 batches per day will be treated. Upon occasional failure of vent system, the emission will increase accordingly.

Other Chemical Species

Emission of other organic chemicals can be determined by using the above method and the appropriate vapour pressure.

7.6 SOLIDIFICATION - CEMENT SILO PARTICULATE EMISSIONS

7.6.1 NORMAL OPERATION

The emission during filling of the cement silo from incoming trucks has been estimated at 20 mg of cement dust per Nm³ of air. Air flow is about 1100 Nm³/h for partial solidification and twice the rate for total solidification. Cement transfer will only be done on the day shift.

8.0 INCINERATION PLANT

8.1 STACK

8.1.1 NORMAL OPERATION

For the 300 000 t/a capacity Facility (ie. two incinerators each operating at 30 000 t/a), it can be assumed that all efforts will be made to ensure that the annual periods of shutdown (8760 - 7000 = 1760 hours) required for maintenance will be staggered so that at least one incinerator will be in operation at all times. The controlled stack emissions will be as given below, and are expected to occur at a height of between 60 - 100 m above ground level, through two flues of 1.3 m diameter each and at an exit velocity of 20 m/s.

Each incinerator and flue gas scrubbing system will be designed for the following conditions:

Flue gas flow at peak Cl (15%) and S (3%) concentrations is:

65 540 Nm³/h (79 600 kg/h)

Flow @ 50% excess air and dry basis 25 400 Nm³/h

Maximum emissions at 50% excess air and dry basis:

Particulates	-	50 mg/Nm ³	
HCl	-	50 mg/Nm ³	
SO ₂	-	200 mg/Nm ³	
HF	-	5 mg/Nm ³	
NO _x	-	200 mg/Nm ³	
CO	-	250 mg/Nm ³	(Short term peak could be 5 times higher.)

Destruction and removal efficiency (DRE) for each principal organic hazardous constituent designated in the waste feed (POHC) - better than 99.99%

$$\text{DRE} = \frac{\text{Win} - \text{Wout}}{\text{Win}} \times 100 \text{ percent, where:}$$

Win is the mass feed rate of 1 POHC in the waste stream going into the incinerator, and

Wout is the mass - emission rate of the same POHC in the exhaust prior to release to the atmosphere.

Outlet temperature 130°C

Annual operating time 7000 hours

The average flue gas flow is 90% of the design flow indicated above.

The controlled emissions described above were provided to the Ontario Research Foundation (ORF), who advised Monenco of the required exit velocity. For further information, refer to the atmospheric conditions report (Ref: ORF²⁰).

8.1.2 UPSET CONDITION - SCRUBBER FAILURE

In the event of a flue gas scrubber failure due to power loss, the following sequence of events will occur, based on the input from the incinerator consultant EEC/Von Roll:

- feed to incinerator will automatically be shut off immediately.
- gas flow will decrease to about 10% of normal in 4 minutes.

- in less than two minutes (two minutes being used for risk assessment) the emergency power generator will assume the supply to the pumps at the scrubber.
- within the less than two minute period, the emergency water supply continues to meet the gas quenching requirement. The quenching water will also perform some gas scrubbing functions.

The removal efficiency of scrubbing during the two minute period with respect to untreated flue gas was estimated to be:

- 70% for particulates
- 50% for HCl
- 40% for HF
- none for SO₂ and NO_x

At the end of the two minutes, concentration of contaminants in the emitted gas will be as normal but gas flow will continue to drop to 10% of normal, as previously noted.

The contaminant concentration at 50% excess air and dry basis will be as follows:

	Before Scrubber	After Scrubber	Two minute Scrubber Failure
	mg/Nm ³	mg/Nm ³	mg/Nm ³
Particulates	5 757	50	1 730
HCl	25 236	50	12 618
SO ₂	9 787	200	9 787
HF	480	5	288
NO _x	285	200	285
Total Organic Hydrocarbons		30	

The above data is included here for reference only. The gas emission in terms of ground level concentrations at the point of impingement have been analyzed by the Ontario Research Foundation (Ref: ORF²⁰)

EMISSION CALCULATION #1

Scenario

Unloading truckload of semi-pumpable organic waste through unloading tanks (reception basins).

Assumptions:

Opening area of basin ----- 2 m^2
Air velocity through opening into the basin ----- 0.3 m/s
Mean annual temperature ----- 10°C
Reference hydrocarbon ----- toluene
Hydrocarbon in vent air ----- 20% saturated average
Time during which basin is open ----- 15 minutes/shipment

Calculations:

Volume of external air vented through the basin opening
 $= 2 \times 0.3 \times 60 \times 15$
 $= 540 \text{ m}^3/\text{shipment}$
Vapour pressure of toluene at 10°C = 13 mm Hg or 0.171 atm.
Assume air averages 20% saturation over 15 minute period.
Vol. fraction of toluene = $13/760 \times 20\%$
 $= 0.00342$
Vol. of toluene in air = 1.85 m^3 at 10°C
 $= 1.78 \text{ m}^3$ at 0°C or 7.3 kg
 (Molecular Weight = 92)

Assume efficiency of activated carbon adsorber is 90%.

Loss of toluene to atmosphere = 0.18 Nm^3 per shipment

For 6 shipments per day, loss of toluene to atmosphere = $0.18 \text{ Nm}^3 \times 6$
 $= 1.08 \text{ Nm}^3/\text{d}$
 or $270 \text{ Nm}^3/\text{a}$

Other Chemical Species:

Emissions of other organic chemicals can be determined by using the above method and the appropriate vapour pressure.

EMISSION CALCULATION #2

Scenario

Unloading organic waste into storage tanks.

Since the organic waste receiving tanks are tied into the same vent system used for the organic waste storage tanks, it is immaterial whether the waste is unloaded into the receiving tank and then transferred to storage or unloaded directly to storage.

The vent gas system will be maintained at a pressure of between 107 kPa and 169 kPa (absolute pressures) by the admission of nitrogen as a blanketing gas. Release of gas from the vent system is not required unless there is a large change in the vapour space of the tanks due to a large difference between waste input and output. If the pressure reaches the upper end of the operating range, excess gas will be bled off to the incinerator.

The assumption of 100% saturation will represent a worst case scenario when bleed off is required.

Calculations:

1. Average Unloading Rate

Average volume of a shipment = 15 m^3

Vapour pressure of toluene at 10°C is 13 mm Hg

At the maximum pressure of 169 kPa (1270 mm Hg), the volume fraction of toluene = $13/1270$
= 0.01023

volume of toluene vapour = 15×0.01023
= 0.1535 m^3 at 1270 mm Hg and 10°C
= 0.2475 Nm^3 per shipment

In the case where the activated carbon adsorber must be used, i.e. both incinerators are unavailable, the atmospheric emission of toluene would be 0.2475×10 shipments/day $\times$ 10% loss through adsorber = $0.25 \text{ Nm}^3/\text{day}$

2. Maximum Unloading Rate

If the unloading is done at the maximum rate of 70 L/s (for simultaneous operation of several stations) and the pressure in the tank vent system has reached the upper end of its operating range, then the instantaneous toluene release rate before the carbon adsorber will be

$0.07 \text{ m}^3/\text{s} \times 0.01023$
= $0.00072 \text{ m}^3/\text{s}$ at 10°C and 1270 mmHg
= $0.0011 \text{ Nm}^3/\text{s}$

If the carbon adsorber is in service, that is both incinerators are not available which is extremely unlikely, then, with a 90% removal efficiency, the instantaneous toluene emission rate will be $0.00011 \text{ Nm}^3/\text{s}$.

Other Chemical Species:

Emissions of other organic chemicals can be determined by using the above method and the appropriate vapour pressure.

EMISSION CALCULATION #3

Scenario

Unloading truckload of cyanide bearing sludge into unloading tank (reception basin) partially filled with water.

Assumptions:

Air velocity into basin opening - 0.3 m/s

Opening area of basin - 2 m²

Basin is open for 15 minutes per shipment with continuous air ventilation.

Mean annual temperature - 10°C.

Total concentration of cyanide in liquid is 10 g/L expressed as cyanide ion (which is possibly the upper end of cyanide concentration range in raw wastes) and the pH is 9.5.

Calculations:

Based upon the following relationships:

1. $[Zn^{++}][CN^-] = 1.3 \times 10^{-17}$ (dissociation constant)
 $[Zn(CN)_4^{=}]$
2. $[Zn^{++}] + [Zn(CN)_4^{=}] = [Zn^{++}]_{Total}$
3. $\frac{[H^+][CN^-]}{[HCN]} = 4.93 \times 10^{-10}$ (dissociation constant)
4. $[H^+] = 10^{-pH}$, which at pH = 9.5, equals 3.16×10^{-10}
5. $4[Zn(CN)_4^{=}] + [CN^-] + [HCN] = [CN^-]_{Total}$

The undissociated HCN in solution at a pH of 9.5 is calculated to be about 3.5 ppm (mole). To include a safety factor of 2 times for data uncertainty, 7 ppm (mole) of HCN in solution is used. At a temperature of 10°C at which HCN vapour pressure is 400 mm Hg, the concentration of HCN in the vapour in equilibrium with this solution is about 3.7 ppm (mole). If the temperature rises to 26°C, then the equilibrium vapour concentration equals that of the solution.

The volume of air passed through the basin opening during the 15 minute period is:

$$2 \text{ m}^2 \times 0.3 \text{ m/s} \times 60 \times 15 \\ = 540 \text{ m}^3$$

$$\begin{aligned} \text{At } 10^\circ\text{C, HCN per shipment assuming vent air is saturated} \\ &= 540 \times 3.7 \times 10^{-6} \\ &= 0.001976 \text{ m}^3 \\ &= 0.0019 \text{ Nm}^3 \end{aligned}$$

Assuming a 90% removal efficiency of the water scrubber, the HCN emission to the atmosphere would amount to about 0.00019 Nm³ per shipment at the assumed mean annual temperature of 10°C.

The vent air is likely to be only partially saturated. If the vent air is conservatively assumed to be 60% saturated, HCN emitted per shipment will be:

$$0.00114 \text{ Nm}^3$$

and HCN emitted to atmosphere after water scrubber will be 0.000114 Nm³ per shipment.

For waste solution with total cyanide concentration of 1000 mg/L (average concentration range), the undissociated HCN in solution at pH of 9.5 and 10°C is about 4.4 ppm (mole) (include a safety factor of 2). The HCN in vapor in equilibrium is about 2.3 ppm (mole), which is in the same order of magnitude as the previous case.

EMISSION CALCULATION #4

Scenario

Evaporation from open drums of organic waste into fume exhaust system.

Assumptions:

Reference hydrocarbon is toluene at 25°C

All drums are ring-top lid type, 55.5 cm diameter and have had the lids removed.

Stagnant vapour layer between the liquid surface and the point where the toluene vapour pressure is negligible due to air sweeping is 5 cm thick.

Normally, at 300 000 t/a plant throughput a total of 20 drums will be open at a time continuously for 7 hours/day, 250 days/a. During peak unloading periods when all 8 transfer stations are in use simultaneously, a maximum of 40 drums will be assumed to be open.

Calculation:

The rate of gas diffusion N , in g moles/(cm² .s), is given by the following equation:

$$N = D * P * (P_{A1} - P_{A2}) / (R * T * Z * P_{BM})$$

where, for toluene-air system, the following apply:

$$D = \text{diffusivity} = 0.086 \text{ cm}^2/\text{s}$$

$$P = \text{pressure} = 1 \text{ atmosphere}$$

$$P_{A1} = \text{vapour pressure of toluene} = 30 \text{ mm Hg or } 0.04 \text{ atmos}$$

$$P_{A2} = 0$$

$$P_{BM} = \text{log mean of } P_{B1} \text{ and } P_{B2} \\ (\text{air fraction of total pressure at locations corresponding to } A1 \\ \text{and } A2) \\ = 0.98$$

$$R = \text{gas constant, } 82.06 \text{ cm}^3 \text{ atm}/(\text{g mole} \cdot ^\circ\text{K})$$

$$T = 25^\circ\text{C or } 298 \text{ K}$$

$$Z = \text{diffusing distance} = 5 \text{ cm}$$

$$\text{From the above } N = 0.029 \times 10^{-6} \text{ g mole}/(\text{cm}^2 \cdot \text{s})$$

$$\text{Cross sectional area of drum} = 2420 \text{ cm}^2$$

$$\text{Diffusion rate} = 70 \times 10^{-6} \text{ g mole/s per drum} \\ = 1.56 \times 10^{-6} \text{ Nm}^3/\text{s/drum}$$

In order to cover any uncertainty in the above model, a safety factor of 3 times the calculated diffusion rate will be used, that is;
diffusion rate = $4.7 \times 10^{-6} \text{ Nm}^3/\text{s/drum}$

$$\begin{aligned} &\text{normal daily loss by evaporation} \\ &= 4.7 \times 10^{-6} \times 20 \times 60 \times 60 \times 7 \text{ hrs} \\ &= 2.4 \text{ Nm}^3 \end{aligned}$$

During peak unloading periods when up to 40 drums may be open simultaneously, the instantaneous loss rate could be

$$4.7 \times 10^{-6} \times 40 = 0.00019 \text{ Nm}^3/\text{s}$$

After the carbon adsorber, better than 90% of the organic contaminants will have been removed and the emission to the atmosphere will not exceed $0.000019 \text{ Nm}^3/\text{s}$.

Other Chemical Species:

Emissions of other organic chemicals can be determined by using the same method as for toluene but must take into account the appropriate vapour pressure and diffusivity.

EMISSION CALCULATION #5

Scenario

Unloading drums of liquid organic waste by vacuum hose.

Assume unloading station consists of a 16 m^3 receiving tank, a vacuum pump and some 2 in. nominal dia. pipe.

System volume = 16 m^3 approximately

Assume reference hydrocarbon is toluene at 25°C , vapour pressure 30 mm Hg, and absolute pressure in receiver is 400 mm Hg.

The estimated air leakage for one unloading station is about 3 kg/hour or about $2.3 \text{ Nm}^3/\text{hour}$. If this air becomes saturated (conservative) with toluene vapour at 25°C , the mole fraction of toluene = $30/400 = 0.075$

$$\begin{aligned}\text{Volume of toluene} &= 0.075 \times 2.3 \\ &= 0.173 \text{ Nm}^3\end{aligned}$$

Now consider establishment of initial vacuum.

Assume 16 m^3 receiver is full of air saturated with toluene vapour at 25°C and 760 mm Hg total pressure.

$$\begin{aligned}\text{Volume fraction of toluene in air} &= 30/760 \\ &= 0.03947\end{aligned}$$

$$\begin{aligned}16 \text{ m}^3 \text{ at } 25^\circ\text{C} \text{ and } 760 \text{ mm Hg} &= 16 \times 273/298 \\ &= 14.6577 \text{ Nm}^3\end{aligned}$$

$$\text{Toluene vapour contained} = 0.5786 \text{ Nm}^3$$

During evacuation assume no new vapourization takes place.

$$16 \text{ m}^3 \text{ at } 25^\circ\text{C} \text{ and } 400 \text{ mm Hg} = 16 \times \frac{273}{298} \times \frac{400}{760}$$

$$= 7.7146 \text{ Nm}^3$$

$$\text{and toluene in vapour space} = 0.3045 \text{ Nm}^3$$

$$\text{toluene evacuated with air} = 0.5786 - 0.3045$$

$$= 0.2741 \text{ Nm}^3$$

Now consider displacement of gas/vapour as receiver is being filled. As a worst case, assume that the gas expelled is saturated with toluene at 25°C and 400 mm Hg, i.e. toluene/air ratio = 0.075.

Gas expelled = 80% of $16 \text{ m}^3 = 12.8 \text{ m}^3$ at 25° and 400 mm Hg
= 6.17 Nm^3 at 0°C and 760 mm Hg

Toluene in gas = 0.463 Nm^3

This is more conservative than basing on 50 drums of liquid which is equivalent to 10 m^3 of volume displacement.

Other Chemical Species

Emissions of other organic chemicals can be determined by using the same calculations as for toluene but substituting the appropriate vapour pressure.

EMISSION CALCULATION #6

Scenario

Cyanide bearing waste in oxidation reactor.

Total cyanide concentration = 1000 mg of CN^-/L

Using the same five relationships shown in Emission Calculation #3, the following results can be obtained:

	<u>pH = 9.5</u>	<u>pH = 7.5</u>
Mole fraction of HCN in liquid =	4.4×10^{-6}	210×10^{-6}
(include a safety factor of 2)		
Vapour pressure of HCN @ 60°C =	2599 mm Hg	2599 mm Hg
Mole fraction of HCN in vapour =	15×10^{-6}	717×10^{-6}
or 15 ppm		717 ppm

Normal reactor pH = 9.5

Vacuum in reactor = 0.05 in. water gauge. (Industrial Ventilation Manual of Recommended Practice)

Crack velocity = 540 ft/min

Assume 0.125 in. crack for half circumference of 24 ins. dia. manhole.

Air gap = $24 \times 0.5 \times 0.125 = 4.76 \text{ ins.}^2$

Air flow at 540 ft/min = $\frac{4.7}{144} \times 540 = 17.7 \text{ ft}^3/\text{min}$

= $0.5 \text{ m}^3/\text{min}$

Volume of cyanide in exhausted air = $0.5 \times 15 \times 10^6 \text{ Nm}^3/\text{min}$
= $7.5 \times 10^{-6} \text{ Nm/min}$

APPENDIX B.2

ENGINEERED CONTAINMENT

ENGINEERED CONTAINMENT

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1.0 INTRODUCTION

OWMC have a stated principal that the Facility should have two levels of containment, one engineered and one natural. The purpose of containment is to inhibit the release of liquid contaminant to the environment.

An assessment has been undertaken by Gartner Lee Associates Limited (GLAL) to compare the natural containment ability of the site(s). This appendix describes the information provided by Monenco to assist in this assessment.

The Engineered Containment features to be incorporated in the Facility design are described in the "Status Report - Facility Design" (Ref: MONENCO¹⁹) and supplemented by this appendix.

Monenco Ltd. developed a range of sixteen spills and leak event scenarios for consideration in the evaluation. From the sixteen event scenarios, three scenarios were used to compare the natural containment ability of the site(s).

In developing the scenarios it was necessary to establish several assumptions in the absence of more definite data. These assumptions are of a conservative nature and are contained later in this document.

2.0 ENGINEERED CONTAINMENT

Engineered containment consists of features to be incorporated in the Facility design to prevent the migration of liquid contaminant to the environment by means of an available pathway.

2.1 OFFSITE MEASURES

The Facility site will be isolated from the areas beyond the boundaries by means of engineered features. Streams and drainage paths which convey surface water runoff originating outside the site boundaries will be redirected by means of berms and ditches. This will create an isolated and controllable area within the site boundaries.

2.2 WITHIN SITE CONTAINMENT

The Facility area containment designation for storm water and in plant drainage systems are:

- Uncontaminated
- Potentially contaminated, and
- Contaminated.

All Facility containment systems are described in the "Status Report - Facility Design" (Ref: MDNENCO¹⁹).

3.0 ASSUMPTIONS

For the purposes of developing scenarios for use in the comparison of natural containment offered by different sites, the following conservative worst case assumptions were incorporated:

3.1 ENGINEERED CONTAINMENT WILL FAIL

It is recognised that engineered systems, vessels, equipment and physical features, such as dykes, of any facility could eventually fail, despite extensive precautions being taken in the design and operation of the Facility.

3.2 CONTAMINATION OF THE GROUND WILL OCCUR

Contamination of the ground will occur as the result of a failure of engineered containment.

3.3 LEAKAGE OF CONTAMINATION WILL BE CONTINUOUS

Minor leaks are assumed to be continuous and undetectable until the Facility is decommissioned. The leakage rates for such events are impossible to quantify precisely. For the purposes of creating practical criteria, however the leak is exaggerated to be approximately that of a continuously flowing pipe with a flow rate of .14 cubic metres per hour.

3.4 RESIDUAL QUANTITIES OF WASTE WILL REMAIN

It is assumed that no cleanup can be 100% effective. Experience has shown that any cleanup operation can be expected to recover between 90% and 99% of the spilled material. The 1% to 10% remaining in the soil is considered "residual waste". This residual would only be removed when the Facility is decommissioned and dismantled.

3.5 SPILLS AND LEAKS IN THE CENTRAL OPERATING AREA WILL BE OF UNTREATED AND UNDILUTED WASTE

As a spill or leak could occur prior to any treatment and at virtually any location within the central operating area it is assumed as a "worst case" that any material involved in an event will be untreated and undiluted.

3.6 SPILLS AND LEAKS MAY OCCUR AT ANY LOCATION ON SITE

It is possible that the location of events is predictable within certain general areas, however, as a conservative approach it is assumed that spills or leaks can occur at any location within the site boundaries.

4.0 SPILLS AND LEAK SCENARIOS

For the purpose of evaluating the ability of the sites to provide natural containment, Monenco Ltd. developed a list of potential events, however unlikely these might be, in which liquid contaminants could be released. The list was compiled by considering each area where special wastes are handled or stored and then examining how contaminants could reach the environment. Details of these events were then provided to Gartner Lee Associates Limited, who evaluated them from a hydrogeologic prospective (Ref: GLAL⁷).

The descriptions which follow summarize the following features for each potential event:

- Definition of the type of leak/spill.
- Character of the potential contaminant.
- Maximum estimated quantity or rate of leakage.
- Residual amount remaining after cleanup.
- Pathway, or the potential route for a spilled or leaking contaminant to take to reach the surrounding soil.

In considering each event, all assumptions were taken to be extremely conservative so that they would produce a "worst case" approach. The events were then grouped by Gartner Lee Associates Limited to produce three scenarios for their assessment of the candidate sites on a comparative basis, as described in Section 5.0 Summary (p. B.2-11).

Event 1 Receiving Basin Ruptures. This event assumes that a full, rear opening tanker truck of 40 m³ capacity containing untreated waste has just commenced unloading when the receiving basin ruptures.

Detection would be immediate due to the drop in the level of the tank but the residual left after cleanup is estimated to be in a range of 0.4 to 4 m³. The potential pathway would be through a crack or leak in a drain, as shown on Exhibit 1 (p. B.2-13). This event constitutes a major spill scenario.

Event 2 Truck Overturns. This event assumes that a full tanker truck of 40 m³ capacity containing untreated waste overturns in the Facility, spilling its complete contents.

Visual detection would be immediate, while the residual left after cleanup is estimated to be in the range of 0.4 to 4 m³. Potential pathways to the subgrade could be through cracks or failed construction joints in the paving, a fault in the contaminated sewer pipe or directly if the truck overturned on a grass or gravelled area. This event constitutes a major spill scenario.

Event 3 Potentially Contaminated Sewer Fails. This event assumes that coincidentally a storage tank ruptures, the containment dyke collapses and the sewer line fails. The maximum quantity of 120 m³ in the storage tank could go to the soil via the failure in the sewer pipe. After clean up it is estimated that there could be a residual of 1.2 to 12 m³ of waste. This event constitutes a major spill scenario.

Event 4 Potentially Contaminated Pond Fails. This event assumes both liners of a potentially contaminated pond rupture, releasing diluted organic or inorganic waste. The quantity could be up to 10,000 m³ for a full pond.

Detection would be either visual, if the pond level dropped quickly, or by local monitor wells in the case of a slow leak,

and the residual material could range from 100 to 1000 m³. The pathway would be directly into the soil surrounding or beneath the pond.

Event 5 Dry Bulk Unloading Pits Fail (Incinerator or Solidification).

This event assumes that the dry bulk unloading pits, which normally contain only dry waste, become wetted, either from the fire fighting deluge system or ingress of water from the soil at high water table. The water table drops and allows water to move out through cracks in the concrete.

The maximum estimated volume would be 100 m³ leaking from the bottom of the waste pits.

Detection would be by area monitor or perimeter wells and the pathway would be directly into the soil at 7 m below grade.

Event 6 Pipe Ruptures or Pipe Connection Breaks. This event assumes that on the piperacks, either a pipe ruptures or a pipe connection breaks releasing up to 10 m³ of either treated or untreated liquid waste.

Detection would be by process monitoring, which would shut the line down automatically, or by an alarm followed by manual shutdown. The residual is estimated to be up to 1 m³, which could be diluted by flush water if over a paved surface. The pathway would be through cracks in paving, down foundations or directly onto grassed/gravelled areas.

Event 7 Incinerator or Physical/Chemical Storage Tank Fails. This event assumes that a storage tank ruptures, the dyke containment wall collapses and up to 120 m³ of organic (Incinerator) or 40 m³ of inorganic (Phys/Chem) waste is released.

Detection should be immediate, either visually or from a process alarm, with the residual after cleanup being up to 12 m^3 or 4 m^3 for organic or inorganic wastes respectively. The pathways could be directly to soil, through paving cracks or potentially contaminated drain failure (Event 3 p. B.2-6).

Event 8 Leakage at Pump Seals and/or Pipe Joint. This event assumes that there is leakage from pump seals or pipe joints. Should this happen a release of up to 1.0 m^3 per week of treated or untreated waste could occur.

Detection would either be visual or during routine maintenance but, as all pipes are above paved areas, the pathway could be down footings or through cracks in the paving. This constitutes a minor leak with a leakage rate of 0.14 m^3 per hour as further explained in Section 3.3 (p. B.2-3).

Event 9 Floor Slab, Dyke Wall, Roadway Leaks. This event assumes that leakage occurs through floor slabs, paved roadways, grass verges, despite being minimized by regular inspection and repair to caulking. Spills or leaks would be flushed to the drainage system but any cracks in the road surface or construction joints could permit a pathway to the soil. This constitutes a minor leak with a leakage rate of 0.14 m^3 per hour as further explained in Section 3.3 (p. B.2-3).

Event 10 Floor Drain Sump Pump Fails. This event assumes that the floor drainage system fails, possibly due to a sump pump stopping, alarm malfunction and the concrete sump leaks into the surrounding soil. Detection would be either visual if the sump fills faster than the leakage, or during routine maintenance. This constitutes a minor leak with a leakage rate of 0.14 m^3 per hour as further explained in Section 3.3 (p. B.2-3).

Event 11 Materials Pipeline to Landfill Fails. This event assumes that the rupture of the pipeline conveying low solids from the solidification process to the landfill occurs. This could allow up to 200 m³ of material to be spilled. The deficiency of material at the landfill cell should ensure rapid detection. Escaping material would be contained in potentially contaminated drainage ditches along the pipeline and any residual would be washed to the potentially contaminated drainage pond.

Event 12 Landfill Materials Truck Overturns. This event assumes that a truck delivering high solids material to the landfill overturns, up to 20 t of the material could be spilled. As this material is treated and non-flowable, only a small residual might arise if the spill took place during a rainstorm, and this would be washed to the potentially contaminated drainage pond.

Event 13 Potentially Contaminated Landfill Drainage Ponds and Ditches Leak. This event assumes that drainage ponds or ditches could leak very dilute aqueous contaminants. Normally these ponds would be nearly empty, they are of a temporary nature and would be excavated for subsequent landfill cell development.

Event 14 Engineered Landfill Cells Leak. This event assumes that leakage from the engineered landfill cells occurs due to development of leachate springs or seeps following failure of the underdrain leachate collection system.

Detection would be by landfill monitors and visual inspection.

Event 15 Landfill Leachate Collection System Fails. This event assumes that failure of the underdrain leachate collection system occurs as a separate event. Pathways would depend on the ground water flow direction.

Event 16 Landfill Leachate Holding Pond or Transfer Pipes Fail. This event assumes that leakage could occur in the leachate transfer system or holding ponds. Flow would normally be by gravity and, below the water table, leakage should be inward. The holding pond may contain either a single or double liner. The pathway would be through the liner to the soil.

A comparative assessment of the ability of each site to provide natural containment is included in the report entitled: "Site Selection Process Phase 4A; Selection of Preferred Site(s) - Geologic, Hydrogeologic and Geotechnical Considerations" (Ref: GLAL⁷).

3.0 SUMMARY

Gartner Lee Associates Limited have used the following three scenarios, from the range of scenarios provided by Monenco Ltd. in their comparative evaluation of the sites (Ref: GLAL⁷).

The scenarios described in their report, and reprinted here, are described as the spill residual scenario, the subsurface leak scenario and the landfill leachate scenario.

(1) Spill Residual Scenario:

"This scenario assumes a contaminant residual would remain after the clean-up of a major spill or leak. Such an event could include a tanker truck overturning with spillage of its contents. Monenco (1985b) has estimated that a maximum volume of contaminated soil of about 4 m³ may be left as a residual that could not be readily accessed for remediation. Residual dimensions of 3 m x 3 m x 0.5 m (vertical dimension) were assumed for modelling purposes. This represents a liquid volume of about 1 m³ to 2 m³ in the soils. Since this waste residual could be present in the granular bedding below the paved areas or within the fractured zone of the underlying clays, it was assumed that a totally effective remediation could not be implemented during site operations."

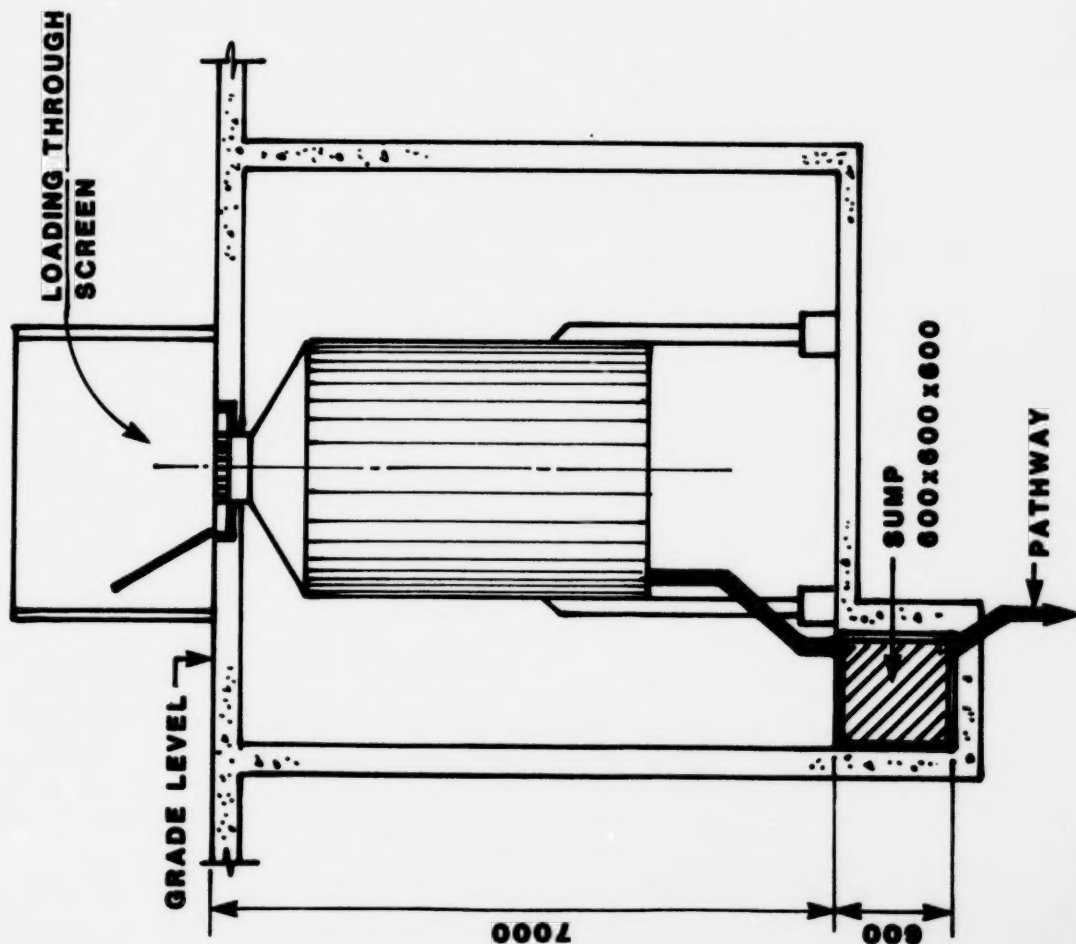
(2) Subsurface Leak Scenario:

"Monenco Limited (1985b) has indicated that minor leaks could occur from several sources at the plant facilities, via cracks in building foundations and sumps, leaking joints in pipes, and leaking packing on valves, etc. Some of these leaks could potentially remain undetected until decommissioning, assumed to be about 20 years from

start-up, for modelling purposes only. Realistically, multiple minor leaks could occur at different times throughout the facility life. This analysis considered a single subsurface leak located at 8 m below surface. The source is assumed to be small (0.1 m x 0.1 m) and the leak assumed to occur for the assumed 20 year operational life of the facility."

(3) **Landfill Leachate Scenario:**

"The hydrogeologic site comparison incorporates a conservative ('worst case') approach to contaminant release. Because leachate characteristics cannot be fully anticipated, it has been assumed that the leachate could contain trace quantities of organic and inorganic contaminants which could represent a health and/or environmental concern. It is also assumed that leachate will be produced and start to migrate from the base of the landfill from the initial start up of the facility. The leachate will be sampled and tested to establish characteristics."



ASSUMPTIONS

- 1 UNTREATED, UNDILUTED/ORGANIC OR INORGANIC WASTE
- 2 VESSEL LEAKS CONTINUOUSLY
- 3 LEAK DETECTOR FAILS
- 4 SUMP LEAK UNDETECTED
- 5 SUMP REMAINS FULL
- 6 FLOW IS CONTINUOUS, EQUAL TO FLOW THROUGH $\frac{1}{8}$ " BORE PIPE AT $.14\text{m}^3/\text{HR}$

EXHIBIT 1

TANK TRUCK UNLOADING

APPENDIX C
FACILITY CHARACTERISTICS INFORMATION

APPENDIX C
INTRODUCTION

The facility characteristics information contained in this Appendix was prepared in detail for analyses by other members of the site selection team. As identified in Chapter 1 (p. 7), this information has been developed based on a 300 000 t/a capacity Facility operating in the "Total Solidification" mode.

Table C.1, Waste Quantities and Characteristics for 300 000 t/a Capacity, was used by M.M. Dillon Ltd. as the basis for their transportation analysis (Ref: MMD¹⁷), which generated data on:

- transportation risks,
- transportation impacts, and
- transportation costs

for further analysis by the site selection team.

Table C.2, Anticipated Noise Levels was used by SS Wilson and Associates, a sub-consultant to M.M. Dillon Ltd., as the basis for their noise analysis (Ref: MMD¹⁷) which generated data on:

- noise impacts

for further analysis by the site selection team.

Table C.3, Employment Levels, was used by other members of the site selection team as input to their impact analyses.

Table C.4, Operating Area Information for Tax Assessment Purposes 300 000 t/a Capacity was used by Clayton Research Associates Limited for their Municipal Finance and Services Analysis (Ref: CLAYTON²).

APPENDIX C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
1. Organic Sludge & Still Bottoms	247 Halogenated Still Bottoms	Spent Solvent or Waste Oil Recoverers	0	0	-	-	-
	248 Non-Halogenated Still Bottoms	Solvent Recovery Operations	8 470	8 470	-	-	-
	252 Solid or Sludge Tannery Wastes	Leather Shavings with Chrome	14 275	-	14 275	-	-
	257 Phenolic Wastes	Phenolic Oil, Toluene Diisocyanide Residue	465	465	-	-	-
	261 Polymeric Resin	Polyester, Urethane, etc.	11 550	-	11 550	-	-
	263 Other Polymeric Wastes	Kettle Bottoms, Thermo- plastic Resins	2 025	2 025	-	-	-
	446 Degreasing Sludge	Grease and Oily Soil Containing Trichloroethane (TCE)	490	-	490	-	-
2. Solvent & Org. Solution	523 Tank Bottom Sediments		125	-	125	-	-
			37 400	10 960	26 440	-	-
	211 Halogenated Solvents with Heavy Metals	Methylene Chloride, 1, 1, 1, Trichloroethylene Used for Metal Cleaning	1 820	1 820	-	-	-

TABLE C.1

Page 2 of 10

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
2. Solvent & Org. Solution (Cont'd)	212 Halogenated Solvents with Other Metals	Surface Cleaning and Degreasing Solvents	70	70	-	-	-
	213 Other Halogenated Solvents	Freon with Other Solvents Used in Chemical Processing	490	490	-	-	-
	214 Non-Halogenated Solvents with Heavy Metals	Toluene, Benzene, Xylene Contaminated with Catalysts	0	0	-	-	-
	215 Non-Halogenated Solvents with Other Metals	Acetone, Methylisobutyl- ketone (MIBK) used in Paint and Varnish Formulation	0	0	-	-	-
	216 Other Non-Halogenated Solvents	Methylethylketone and Other Solvents Contami- nated with Dirt	0	0	-	-	-
	217 Unspecified Solvents	Alcohols and Mixtures of Solvents	150	150	-	-	-
	221 Organic Liquids with Metals and Halogens	Dyes	0	0	-	-	-
	222 Organic Liquids with Halogens Only	Chloroform, Carbon Tetrachloride	0	0	-	-	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
2. Solvent & Org. Solution (Cont'd)	223 Organic Liquids with Metals Only	Nickelcarbonyl, Methyl Mercury	0	0	-	-	-
	224 Other Organic Liquids	Creosote and Other Poly Aromatic Hydrocarbons	175	175	-	-	-
3. Oil & Grease			2 705	2 705			
	281 Waste Oil and Mixed Oil	Used Automotive Oil, Hydraulic Oil, Cutting Oil - May Contain Solvents or Metals	1 285	1 285			
4. Oil & Water Mixtures			1 285	1 285			
	283 Oily Mud, Sediment and Water	Crude Oil Tanker Cleaning	1 000	1 000*			
5. Organic & Oily Residues	264 Thermoset Wastes	Urea-Formaldehyde and Thermoset Wastes	0	-	0	-	-
	282 Oil Tank Bottoms	Crude Oil or Sludge from Storage	1 575	1 575	-	-	-
	284 Oily Acidic Solids	Solids from Emulsion Breaking and Re-refining	0	-	0	-	-
	285 Oil Alkaline Solids	Refining Solids	0	-	0	-	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
5. Organic & Oily Residues (Cont'd)	286 Oil/Water Separator Sludge	Oil Cooled Heavy Inorganics	55	55	-	-	-
	288 Oily Wastes with Heavy Metal Contaminants	Steel Rolling Mill Sludges and Mill Scale	0	-	0	-	-
	289 Oily Wastes with Water	Emulsions, Cleanup Water from Garages, Cooling Waters	5 835	5 835	-	-	-
	447 Tetraethyl Lead Sludge	Tank Bottoms	0	-	0	-	-
			8 465	8 465*			
6. Heavy Metal Solutions and Residuals	111 Acidic Solution with Heavy Metals	Pickle Liquor Rinse Water	33 000	-	-	33 000	-
	112 Acidic Solution with Other Metals and Non-Metals	Demineralizer Regenerant	3 000	-	-	3 000	-
	113 Other Acidic Solutions	Boiler Stack Scrubber Water with Dilute Carbonic Acid (H2CO3)	4 000	-	-	4 000	-
	121 Alkaline Solution with Heavy Metals	Rinse Waters from Surface Cleaning of Metals	25 400	-	-	25 400	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
6. Heavy Metal Solutions and Residuals (Cont'd)	122 Alkaline Solution with Other Metals	Deminerallizer Regenerent	1 000	-	-	1 000	-
	123 Other Alkaline Solutions	Cleanup Water from Lime or Cement Kiln	7 400	-	-	7 400	-
	131 Metal Finishing Solutions, Acid	Ammonia Based, Containing Copper, Tin, Lead or Cadmium	1 000	-	-	1 000	-
	132 Metal Finishing Solutions, Alkaline	Contains Strong Complexing Agent and Copper, Tin, Lead and/or Cadmium	200	-	-	200	-
	133 Spent Pickle Liquor from Ferrous and Non-Ferrous Metals	Strong Acids with Iron, Flouride, Hydrochloric Acid (HCl), Sulphuric Acid (H ₂ SO ₄), Nitric Acid (HNO ₃)	8 000	-	-	8 000	-
	141 Aqueous Solutions with Heavy Metals	Cleaning Solutions from Tanks, Trucks, or Railroad Tankers	32 000	-	-	32 000	-
	142 Aqueous Solutions with Other Metals	Rinse Water from Heat Treating Salt Baths, Contain Barium, Aluminum	9 108	-	-	9 108	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
6. Heavy Metal Solutions and Residuals (Cont'd)	143 Aqueous Solutions with Reactive Anions	Bleaching Solutions Con- taining Sulphite, Chlorite, Fluoride, Bromate	22 000	-	-	22 000	-
	244 Photochemical Waste	Most Solutions Non-Toxic Except those with Silver	2 000	-	-	2 000	-
	251 Tannery Wastes - Liquid	Solutions with Hexavalent Chromium	1 000	-	-	1 000	-
	431 Heavy Metal Sludge	Similar to that in 111, 113, 121, 123, 132, 133, 141	22 000	-	-	-	22 000
	433 Other Metal Sludges	Ferric Chloride, Aluminum Oxide, etc.	200	-	-	200	-
	445 Plating or Metal Finishing Sludge	Derived Mostly from 131, 132, 133	4 000	-	-	4 000	-
7. Misc. Chemicals & Products	523 Tank Bottom Sediments		1 000	-	-	1 000	-
	243 Pharmaceuticals and Wastes	Off-Spec. Drugs, Cleanup Waters, etc. Includes Items such as Vitamins	176 308	425	-	154 308	22 000
			425			-	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
7. Misc. Chemicals & Products (Cont'd)	245 Off-Spec or Aged Organics	Can Include Solids or Liquids, Generally in Containers	630	630	-	-	-
	416 Ink Sludge	Sludge Could Contain Solvents and Lead, Cesium, Chromium	125	125	-	-	-
	513 Laboratory Waste Chemicals	Partially Full Small Containers	432	432	-	-	-
			1 612	1 612*	-	-	-
8. Paints & Org. Residuals	254 Adhesives or Glue	Waste Glues Mostly Aqueous, some with Phenols	1 575	1 575	-	-	-
	258 Waste Tar and Residues		3 050	3 050	-	-	-
	262 Latex Wastes	Cleanup Water, Paint, Latex and Acrylic Resins	0	0	-	-	-
	454 Paint Sludge	Drum Bottoms, Spills, Cleanup, etc.	965	965	-	-	-
	455 Paint Sludge Without Heavy Metals	Mostly Latex	545	545	-	-	-
			6 135	6 135	-	-	-

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
9. Aqueous Solution with Org.	225 Aqueous Solution with Non-Halogenated Resi- dues Less Than 10%	Laboratory Mixtures	250	250	-	-	-
	226 Aqueous Solutions with Halogenated Residues Less Than 10%	Waste or Rinse Waters After Degreasing	100	100	-	-	-
	227 Aqueous Solution with Non-Halogenated Organic Residue Greater Than 10%	Laboratory Mixtures	100	100	-	-	-
	228 Aqueous Solution with Halogenated Organic Residue Greater Than 10%	Wash or Rinse Waters After Degreasing	50	50	-	-	-
10. Anion Complexes			500	500*			
	146 Solutions Containing Cyanide	Plating Baths	1 170	-	-	1 170	-
	147 Solutions Containing Sulphides	Plating Baths	30	-	-	30	-
	444 Cyanide Bearing Sludges	Pot Liners from Aluminum Reduction and Scrubber Sludge from Blast Furnaces	400	-	-	400	-
			1 600			1 600	

TABLE C.1

WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
11. Sludges & Inorg. Residuals	151 Inorganic Solids	Foundry Sand with Phenolics	20 000	-	-	-	20 000
	163 Spent Catalyst	Maybe Carbon or Metal	1 000	-	-	-	1 000
	167 Other Inorganic Waste	Ash & Construction Residue	10 000	-	-	-	10 000
	417 Alum & Gypsum Sludges	Waste Water Phosphate, Removal Sludge	400	-	-	400	-
	441 Lime Sludges	From Treatment of Acids and Similar to 431 and Derived from 111, 113, 121, 123, 131, 132, 133, 141	24 400	-	-	24 400	-
	443 Sulphur Sludge	Desulphurization of Flue Gas Non-Reactive but Very Low Bearing Strength	200	-	-	200	-
12. Pesticide & Herbicide	518 Dust Collector Wastes	Dry Lime from Dust Control Baghouse	4 000	-	-	-	4 000
	241 Pesticides and Wastes	Partial Containers, Tank Washings, Off Spec. Product, etc.	140	140	-	-	-
			60 000			25 000	35 000

TABLE C.1

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WASTE QUANTITIES AND CHARACTERISTICS FOR 300 000 t/a CAPACITY

WASTE GROUP	UCD DESCRIPTION	TYPICAL WASTES	QUANTITY t/a	FORM OF WASTE			
				ORGANICS		INORGANICS	
				LIQUIDS & SLUDGES	NON- PUMPABLE	LIQUIDS & SLUDGES	NON- PUMPABLE
12. Pesticide & Herbicide (Cont'd)	532 Equipment and/or Containers Contami- nated with Pesticides	Empty Pesticide Cans	0	-	0	-	-
			140	140	0		
13. PCB Wastes	242 PCB Oils and High Strength (over 500 ppm) Liquids	From Transformers and Capacitors	70	70	-	-	-
			70	70			
14. Clean-up Residuals	512 Spill Cleanup	Oil/Soil Mixture	1 375	-	1 375	-	-
	521 Spent Cartridge Filters	Air Cleaning Filters on Ventilation System	25	-	25	-	-
	528 Pathogenic Wastes	Used Bandages, Dressings	0	-	0	-	-
	531 Contaminated Rags	Cleanup Materials	2 380	-	2 380	-	-
			3 780		3 780		
TOTAL			300 000	31 872*	30 220	180 908	57 000

* Note: Part of these wastes are inorganic liquid/sludge or organic non-pumpable.

APPENDIX C.2

ANTICIPATED NOISE LEVELS

INTRODUCTION

It is generally known that sound is a transmission of energy through solid, liquid or gaseous media in the form of vibrations. These vibrations constitute variations in pressure or position of particles in the medium.

The sound waves in air are tiny oscillations of pressure just above and below atmosphere pressure. These pressure oscillations impinge on the ear drum and are heard as sound.

This sound or airborne noise is composed of sound waves of different intensities and different frequencies or pitches. A complete description of any particular noise must specify both the sound intensity (commonly called the sound pressure level SPL) and the main frequency bands of the noise. The sound intensities at the different frequency bands are then averaged to give an overall noise rating which is measured in decibels (dB) and usually referenced to the "A" weighted scale dB(A).

The "A" weighting scale of a sound level meter was developed to measure the loudness of noise in a manner similar to that of the human ear. This is achieved by attenuating or reducing the sound pressure level (SPL) at low frequencies and increasing it at higher frequencies in an attempt to serve as a single number indicating the relative loudness of noise as heard by the human ear.

The human ear can detect a difference in noise level of 3 to 5 dB(A). In addition, if the noise level from a source is reduced by 10 dB(A), it would appear to be one half as loud as the previous noise.

It is also important to note that sound strength diminishes inversely with distance such that as the distance doubles, the sound amplitude diminishes by half. The usual measuring point reference distance is 1 metre (3 feet) from the sound source resulting in sound strength versus distance (assuming the sound pressure level of 100 dB(A) at 3 feet) as follows:

Distance (feet) From Source	Sound Strength	Sound Pressure Level dB(A)
3'	100%	100
6'	50%	94
12'	25%	88

Sound levels are commonly expressed in two different ways as follows:

- sound pressure level (SPL), and
- sound power level (PWL).

Sound Pressure Level (SPL) is the measure of pressure exerted by sound waves at a given location, expressed in decibels on a logarithmic scale as:

$$\text{Sound Pressure Level (SPL)} = 10 \log \frac{(P)^2}{(\text{Pref})^2} = 20 \log \frac{P}{\text{Pref}}$$

where P is the measured pressure of sound and Pref is a reference pressure level equal to 0.0002 microbar (0.0002 microbar is the lowest sound pressure audible to the average person at a frequency of 1000 Hz; this is also a sound pressure level of 0 dB. One microbar is 14.7×10^{-6} psi).

Sound pressure, expressed in decibels is a measure of the strength of a sound at a specified point or a definite distance from the sound source.

Some typical noise levels are included in the following table:

Sound Pressure Level dB(A)	Subjective Description	Typical Sources
100	Very Loud	Jackhammer, power lawn mower
90		Food blender, subway, truck
80	Moderately Loud	Garbage disposal, diesel train
70		Vacuum cleaner, TV (Audio)
60		Conversation at 3 feet
50	Quiet	Crickets
40		Small town residential area
30	Very Quiet	Very soft whisper
20		Grand Canyon, concert hall
10	Barely Audible	Less than the electrical noise of sound-measurement instruments
0	Threshold of Hearing	

Sound Power Level (PWL) is a measure of the total sound radiation from a sound source. This is especially important in mechanical devices such as electric motors which do not radiate sound uniformly in all directions.

To obtain the sound power level (PWL) of any given machine, a series of sound pressure readings are taken at several points on a defined geometric contour around the machine. The average sound pressure level is determined,

and from this, the average radiated sound power level expressed in decibels, is calculated as:

$$\text{Sound Power Level (PWL)} = 10 \log \frac{W}{W_{\text{ref}}}$$

where W is an average sound power level and W_{ref} is a reference power level equal to 10^{-12} watts.

Typically, the sound pressure level (SPL) at a distance of 3 feet from the sound source is approximately 10 dB less than the sound power level (PWL).

TABLE C.2

Sheet 1 of 10

ANTICIPATED NOISE LEVELS

Basis 300,000 t/a

The equipment noise level that is of most concern to the general public is the noise generated by outdoor equipment. Any interior equipment will have most of the noise attenuated by the building walls.

The noise levels were estimated for a preliminary list of equipment for the design basis described in Chapter 2.

The outdoor equipment is mainly ventilation fans for the various buildings since most operating equipment is installed inside the buildings.

The ventilation fans selected will be quieter than standard ventilation fans so the noise levels generated should be similar or slightly quieter than other industrial buildings.

The noise level for all other equipment was estimated based on typical values for generic types of equipment.

Noise level listed is for each equipment item.

PHYSICAL/CHEMICAL TREATMENT PLANT (BUILDING)

A. EXTERIOR EQUIPMENT

15 Medium Extraction Fans on Roof
2 Silo Blowers
2 Pumps

PWL = 85 dB(A)
PWL = 82 dB(A)
PWL = 94 dB(A)

TABLE C.2

Sheet 2 of 10

ANTICIPATED NOISE LEVELS**B. INTERIOR EQUIPMENT**

3 Large fans	PWL = 92 dB(A)
27 Medium fans	PWL = 85 dB(A)
12 Small fans	PWL = 82 dB(A)
8 Very small fans	PWL = 80 dB(A)
20 Mixers	PWL = 82 dB(A)
5 Pumps	PWL = 94 dB(A)
5 Pumps	PWL = 87 dB(A)
5 Miscellaneous	PWL = 95 dB(A)
1 Compressor	PWL = 85 dB(A)

INCINERATION PLANT (2) BUILDINGS**A. EXTERIOR EQUIPMENT**

14 Medium Extraction Fans on Roof	PWL = 85 dB(A)
4 Small Fans on Roof	PWL = 82 dB(A)
4 Air Cooled Condensers	PWL = 90 dB(A)
10 Chain Conveyors	PWL = 90 dB(A)
2 Kiln Drives	PWL = 85 dB(A)
2 Air Cooled Condensers	PWL = 90 dB(A)

TABLE C.2

Sheet 3 of 10

ANTICIPATED NOISE LEVELS**B. INTERIOR EQUIPMENT**

2 ID Fans	PWL = 95 dB(A)
2 sets Burners on Front of Kiln	PWL = 90 dB(A)
4 sets Secondary Chamber Burners	PWL = 95 dB(A)
2 Auxiliary Boiler FD Fans	PWL = 90 dB(A)
10 Pumps	PWL = 94 dB(A)
40 Fans	PWL = 85 dB(A)
2 Air Compressors	PWL = 95 dB(A)
1 Steam Turbine Generator	PWL = 95 dB(A)
1 Crane	PWL = 85 dB(A)
1 Crusher	PWL = 95 dB(A)
1 Chiller unit	PWL = 82 dB(A)

SOLIDIFICATION PLANT (BUILDING)**A. EXTERIOR EQUIPMENT**

6 Medium Extraction Fans on Roof	PWL = 85 dB(A)
1 Conveyor to Landfill	PWL = 85 dB(A)

B. INTERIOR EQUIPMENT

8 Mixers	PWL = 87 dB(A)
2 Mixers	PWL = 95 dB(A)
10 Pumps	PWL = 95 dB(A)
8 Fans	PWL = 85 dB(A)

TABLE C.2

Sheet 4 of 10

ANTICIPATED NOISE LEVELS

PHYSICAL/CHEMICAL TANK STORAGE (BUILDING)

A. EXTERIOR EQUIPMENT

12 Medium Extraction Fans on Roof

PWL = 85 dB(A)

B. INTERIOR

4 Pumps

PWL = 94 dB(A)

30 Mixers

PWL = 85 dB(A)

INCINERATOR TANK FARM

A. EXTERIOR

6 Pumps

PWL = 91 dB(A)

TANK TRUCK UNLOADING BAYS (ROOF ONLY)

6 Mixers

PWL = 82 dB(A)

10 Pumps

PWL = 84 dB(A)

1 Blower

PWL = 85 dB(A)

13 Small Fans inside Roof

PWL = 82 dB(A)

INCINERATOR RECEIVING TANKS (OUTDOORS)

5 Pumps

PWL = 94 dB(A)

TABLE C.2

Sheet 5 of 10

ANTICIPATED NOISE LEVELS

MAINTENANCE, WORKSHOPS, STORES AND VEHICLE GARAGE (BUILDING)

A. EXTERIOR

7 Medium Extraction Fans on Roof	PWL = 85 db(A)
6 Small Extraction Fans on Roof	PWL = 82 db(A)

B. INTERIOR

4 Miscellaneous	PWL = 85 db(A)
2 Medium Fans	PWL = 85 db(A)

TRUCK WASH STATION (BUILDING)

A. EXTERIOR

No stationary equipment

B. INTERIOR

3 Medium Fans	PWL = 85 db(A)
1 Small Fan	PWL = 82 db(A)
4 Mixers	PWL = 82 db(A)
4 Pumps	PWL = 87 db(A)

FIREWATER POND PUMPHOUSE (BUILDING)

A. EXTERIOR

1 Small Fan	PWL = 82 db(A)
-------------	----------------

TABLE C.2

Sheet 6 of 10

ANTICIPATED NOISE LEVELS

B. INTERIOR

2 Pumps

PWL = 87 db(A)

CLEAN STORMWATER HOLDING POND (OUTDOORS)

1 Pump

PWL = 91 db(A)

POTENTIALLY CONTAMINATED WATER HOLDING POND (OUTDOORS)

1 Pump

PWL = 91 db(A)

STACK

Stack at top

PWL = 63 db(A)

DRUM CONVEYOR (PARTIALLY ENCLOSED)

B. INTERIOR

Conveyor

PWL = 85 db(A)

DRUM STORAGE AND HANDLING BUILDING

A. EXTERIOR EQUIPMENT

13 Medium Extraction Fans on Roof

PWL = 85 db(A)

TABLE C.2

Sheet 7 of 10

ANTICIPATED NOISE LEVELS

B. INTERIOR EQUIPMENT

2 Medium Fans	PWL = 85 db(A)
4 Large Fans	PWL = 85 db(A)
4 Small Fans	PWL = 82 db(A)
4 Pumps	PWL = 87 db(A)
10 Mixers	PWL = 82 db(A)
1 Small Air Compressor	PWL = 85 db(A)

ADMINISTRATION OFFICES

A. EXTERIOR EQUIPMENT

9 Small Exhaust Fans on Roof	PWL = 82 db(A)
------------------------------	----------------

B. INTERIOR

4 Medium Fans	PWL = 85 db(A)
7 Small Fans	PWL = 82 db(A)
1 Compressor	PWL = 85 db(A)
1 Pump	PWL = 87 db(A)

GATEHOUSE AND WEIGH SCALES

A. EXTERIOR EQUIPMENT

1 Small Exhaust Fan on Roof	PWL = 82 db(A)
1 Package Air Conditioners	PWL = 90 db(A)

TABLE C.2

Sheet 8 of 10

ANTICIPATED NOISE LEVELS

EMERGENCY POWER GENERATION (BUILDING)

A. EXTERIOR EQUIPMENT

1 Small Exhaust Fan on Roof

PWL = 82 db(A)

MAIN SUBSTATION (OUTDOORS)

2 Transformers

PWL = 85 db(A)

LANDFILL

A. SURFACE DRAINAGE POND

1 Pump

PWL = 95 db(A)

B. LEACHATE COLLECTION POND

1 Pump

PWL = 95 db(A)

C. EQUIPMENT

In respect of the noise levels associated with equipment working at the landfill, the following points should be noted:

- Noise impacts off-site will vary depending on where the particular active landfill cell is in relation to the perimeter berm.
- Trucks delivering material to a separate landfill site are covered separately under transportation (Ref: MMD¹⁷).

TABLE C.2

Sheet 9 of 10

ANTICIPATED NOISE LEVELS

- New cell development will take place approximately once per year up to year five, increasing to twice a year by year 10 and continuing at this level until year 20. Installation of the containment system will take place at the same time.
- Noise levels are given for the three cell profiles resulting from hydrogeologic and geotechnical constraints, as described in Chapter 4.
- The major source of equipment noise, the exhaust, is assumed to be approximately 3m above their base. It is estimated that the percentage of time that the noise source is above grade will be:
 - 60% for Site LF-1E,
 - 55% for Sites LF-3C and LF-9C, and
 - 85% for Site LF-1E.

TABLE C.2

**ANTICIPATED NOISE LEVELS
FOR LANDFILL EARTHMOVING EQUIPMENT
INCLUDING DAYS/YEAR OF OPERATION**

ACTIVITY	MODE OF OPERATION	EQUIPMENT NO. x TYPE	NOISE dB(A) @ 15m	CASE 1-INTEGRATED			CASE 2-LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/PI-1N	LF-4N/PI-13N	LF-1E/PI-27E
INITIAL SITE DEVELOPMENT	TOTAL SOLIDIFICATION	1 x D9 TRACTOR (DOZER ATTACH.)	87	40	40	48	30	30	48
	PARTIAL SOLIDIFICATION	6 x 637D TANDEM SCRAPER	83-85	29	29	33	25	25	33
	TOTAL SOLIDIFICATION	1 x LARGE GRADER	83						
	PARTIAL SOLIDIFICATION	2 x D6 TRACTOR	86						
	PARTIAL SOLIDIFICATION	1 x BACKHOE	79	19	19	27	10	10	27
NEW CELL DEVELOPMENT	TOTAL SOLIDIFICATION	1 x LARGE VIBRATORY COMPACTOR	80						
	PARTIAL SOLIDIFICATION	1 x MEDIUM COMPACTOR		9	9	12	5	5	12
	PARTIAL SOLIDIFICATION	5 x MISC SUPPORT TRUCKS							
	TOTAL SOLIDIFICATION	2 x D6 TPACTOR	86	40	40	40	40	40	40
	PARTIAL SOLIDIFICATION	5 x TANDEM DUMP TRUCKS							
DAILY OPERATIONS	TOTAL SOLIDIFICATION	1 x LARGE VIBRATORY COMPACTOR	80	20	20	20	20	20	20
	TOTAL SOLIDIFICATION	1 x D8 BULLDOZER	85	100	100	100	200	200	200
	PARTIAL SOLIDIFICATION	1 x LARGE VIBRATORY COMPACTOR	80	-	-	-	125	125	125
	PARTIAL SOLIDIFICATION	1 x LOADER	83	32	32	32	63	63	63
	PARTIAL SOLIDIFICATION	1 x 627 SCRAPER	80	32	32	32	63	63	63
DAILY OPERATIONS	TOTAL SOLIDIFICATION	x SUPPORT TRUCKS		32	32	32	63	63	63
	TOTAL SOLIDIFICATION	1 x D8 BULLDOZER		50	50	50	100	100	100
	PARTIAL SOLIDIFICATION	1 x LARGE VIBRATORY COMPACTOR		-	-	-	63	63	63
	PARTIAL SOLIDIFICATION	1 x LOADER	83	19	19	19	38	38	38
	PARTIAL SOLIDIFICATION	1 x 627 SCRAPER	80	19	19	19	38	38	38
DAILY OPERATIONS	TOTAL SOLIDIFICATION	x SUPPORT TRUCKS		19	19	19	38	38	38
	TOTAL SOLIDIFICATION								
	TOTAL SOLIDIFICATION								
	TOTAL SOLIDIFICATION								
	TOTAL SOLIDIFICATION								

APPENDIX C.3

EMPLOYMENT LEVELS

TABLE C.3 EMPLOYMENT LEVELS

	150,000 t/a CAPACITY					300,000 t/a CAPACITY				
	CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE		CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE	
		Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator		Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator
GENERAL ADMINISTRATION										
Director of Operations	1	1			1	1	1			1
Manager, Operations	1	1			1	1	1			1
Manager, Administration	1	1			1	1	1			1
Manager, Engineering Maintenance	1	1			1	1	1			1
Manager, Lab Services	1	1			1	1	1			1
Supervisor, Marketing	1	1			1	1	1			1
Supervisor, Office Services	1	1			1	1	1			1
Comptroller	1	1			1	1	1			1
Security Officer	1	1			1	1	1			1
Safety & Training Officer	1	1			1	1	1			1
Employee Relations/Public Affairs Manager	1	1			1	1	1			1
Site Superintendent	1	1			1	1	1			1
Secretaries	5	5			5	5	5			5
Marketing/Sales/Purchasing	4	4			4	4	4			4
Accounting	5	5			5	5	5			5
Plant Engineering	1	1			1	1	1			1
Mechanical Engineer	1	1			1	1	1			1
Chemical Engineer	1	1			1	1	1			1
Draftsman	5	5			5	5	5			5
Security Personnel	1	1			1	1	1			1
Nurse	1	1			1	1	1			1
Clerks	3	2	1		2	4	2	1	2	2
SUBTOTAL	37	36	2	7	36	49	47	2	8	47
MAINTENANCE										
Department Head	1	1			1	1	1			1
Foreman	2	2			2	2	2			2
Mechanical Tradesmen	6	5	1		5	10	9	1		9
Electrical Tradesmen	2	2			2	4	4			4
Instrumentation Tradesmen	2	2			2	4	4			4
Vehicle Maintenance Men	1	1			1	2	2			2
Misc. Trades & Labourers	4	4			4	4	4			4
Storekeeper	1	1			1	1	1			1
SUBTOTAL	19	18	1	1	18	28	27	1	1	27

TABLE C.3 EMPLOYMENT LEVELS

Sheet 2 of 3

150,000 c/a CAPACITY										300,000 c/a CAPACITY					
CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE		CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE							
	Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator		Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator						
OPERATIONS															
Incinerator															
Department Head	1	1		1										1	
Production Engineer	1	1		1										1	
Shift Supervisor	4	4		4										4	
Incinerator Operator	4	4		4										8	
Boiler House Personnel	4	4		4										4	
Flue Gas System Operators	4	4		4										4	
Crane Operators	4	4		4										8	
Labourers	2	2		2										4	
SUBTOTAL	24	24	-	24						34	34			34	
PLTS/CREW															
Department Head	1	1													
Production Engineer	1	1													
Shift Supervisor	2	2													
Chemical Operators	8	8													
SUBTOTAL	12	12								23	23			-	
SOLIDIFICATION															
Operators	8	8													
SUBTOTAL	8	8								15	15			-	
LANDFILL															
Shift Supervisor	1														
Operators	1	2													
Drivers	-	1													
Labourers	6	2													
SUBTOTAL	8	-	6							-	-	8	12	-	

TABLE C-3 EMPLOYMENT LEVELS

300,000 t/a CAPACITY									
150,000 t/a CAPACITY									
CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE		CASE 1 INTEGRATED	CASE 2 LANDFILL SEPARATE		CASE 3 INCINERATOR SEPARATE	
	Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator		Phys/Chem Incinerator	Landfill	Phys/Chem Landfill	Incinerator
OPERATIONS									
Tank Farm/Pumping									
4	4			4	4	4			4
SUBTOTAL									
4	4		-	4	4	4	-	-	4
SERVICES									
1	1		-	1	1	1			1
4	4		3	2	8	8			3
7	7		5	2	14	14			4
2	2		1	1	2	2			1
1	1		1	-	1	1			-
8	8		5	5	8	8			5
2	2		1	1	2	2			1
SUBTOTAL									
25	25	-	16	12	36	36	-	24	15
SUBTOTAL OPERATIONS									
81	73	6	46	40	124	112	8	74	53
LABORATORY									
Process Lab									
1	1			1	1	1			1
1	1			1	2	2			2
3	3			3	3	3			1
Analytical Lab									
1	1			1	1	1			1
1	1			1	2	2			2
3	3			3	3	3			1
1	1			1	2	2			2
3	3		1	3	6	6		1	6
SUBTOTAL									
14	14	-	1	14	20	20	-	1	20
TOTAL									
151	141	9	53	108	221	206	11	84	147
TOTAL FOR COMBINED SITES									
150				161	217				231

APPENDIX C.4

OPERATING AREA INFORMATION FOR TAX ASSESSMENT PURPOSES

TABLE C-4 OPERATING AREA INFORMATION FOR TAX ASSESSMENT PURPOSES
300 000 t/a CAPACITY

Page 1 of 5

BLK#	DESCRIPTION OF BUILDINGS	SIZE (M)	AREA (M ²)	CONSTRUCTION	\$/SH	ESTIMATED COST	DESCRIPTION OF HVAC SYSTEM (SEE ATTACHED NOTES)	DESCRIPTION OF FIRE FIGHTING SYSTEM
1.	Physical/Chemical Plant • Control Room • Equipment Room • Laboratory • Office • Washrooms	57 x 82 x 24H Two Floors	9348 Total	Walls and roof constructed of insulated panels. • Insulated panels are made up of insulation sandwiched between metal cladding.	\$ 1095.95	\$10,244,984	Heating provided by Forced Air (Heat Recovery from Incinerator) System (A) and Energy Recovery from Process Extract System (B). Process Ventilation (E) and General Ventilation (F) provided. Heating and cooling for offices and Control Room provided by Water to Air System, Direct Discharge (D).	External Hydrants and sprinkler system for majority of building. Fixed Halon System to be provided for Control Centre. A physical separation/fire barrier shall be provided between areas treating organic wastes and remaining sections of the Phys/Chem Treatment Plant.
2.	Incinerator • Enclosed Portion • Bunkers • Waste Heat Boiler • Flue Gas Treatment • Overhead Crane (6 tonne capacity) • Precipitator • Scrubber • Offices • Control Room • Washrooms • Included in incinerator building cost.	60 x 110 x 23H S/A N/A 4.80x9.50x11.80 (5.3H structural steel) 4.1 Dia. x 18H	6600 N/A N/A N/A N/A	Walls and roof constructed of insulated panels. Precipitator construction to be of the rigid frame/electrode type and will consist of 3 fields.	\$ 1095.95	\$ 7,046,211 \$ 167,089 \$ 345,000 \$ 4,968,000 Included in price of precipitator	Heating provided by Forced Air (Heat Recovery from Incinerator) System (A). General Ventilation (F) provided. Heating and cooling for offices and Control Room provided by Water to Air System, Direct Discharge (D).	Stand pipe and hose cabinets to be located in the incinerator, auxiliary boiler and feedwater treatment areas. Fixed Halon System provided for Control Centre. Local water deluge system to be provided for each feed chute and bunker.
3.	Solidification • Building • Bunker • Overhead Crane (1 tonne capacity)	35 x 37 x 22H S/A	1995 N/A	Walls and roof constructed of insulated panels.	\$ 913.55	\$ 1,780,424 \$ 42,100 \$ 73,968	Heating provided by Forced Air (Heat Recovery from Incinerator) System (A) and Energy Recovery from Process Extract System (B). Process Ventilation (E) and General Ventilation (F) provided.	External Hydrant plus stand-pipe and hose cabinets
4.	Landfill	--	--	--	--	--	--	--

TABLE C.4 OPERATING AREA INFORMATION FOR TAX ASSESSMENT PURPOSES
300 000 t/a CAPACITY

BLANK NO.	DESCRIPTION OF BUILDINGS	SIZE (m)	AREA (m ²)	CONSTRUCTION	S/SN	ESTIMATED COST	DESCRIPTION OF HVAC SYSTEM (SEE ATTACHED NOTES)	DESCRIPTION OF FIRE FIGHTING SYSTEM
5.	Physical/Chemical Tank Farm • Building • Storage Tanks	43 x 73 x 24H Two Floors 3.5 Dia. x 4.2H 2.0 Dia. x 3.5H 2.3 Dia. x 4.2H 1.5 Dia. x 2.5H 9.0 Dia. x 12.0H 1.5 Dia. x 2.5H	6278 Volume (M ³) 40.5 10.0 20.0 4.4 80.0 4.4	Walls and roof constructed of insulated panels. FRP Material FRP Material FRP Material FRP Material FRP Material FRP Material	\$ 913.55	\$ 2,867,622 \$ 9,446,376	Heating provided by Forced Air (Heat Recovery from Incinerator) System (A). General Ventilation (F) provided. Tanks to be provided with process ventilation (E).	External hydrants plus sprinkler system for areas storing inorganic wastes. External hydrants plus foam deluge system for areas storing organic containing wastes.
6.	Incinerator Tank Farm • Storage Tanks	 4.0 Dia. x 10.0H 3.5 Dia. x 4.2H 2.2 Dia. x 2.7H 4.0 Dia. x 4.8H	 Volume (M ³) 135.7 40.5 10.0 60.0	Carbon Steel Carbon Steel Carbon Steel Carbon Steel	N/A	\$ 3,779,820		External monitor hydrants plus foam.
9.	Tank Truck Unloading • Building • Concrete Basement • Storage Tanks	30x82x6 clear 3.6 Dia. x 4.0H 3.6 Dia. x 4.0H	2460 Volume (M ³) 40.5 40.5	Walls and roof constructed of insulated panels. Carbon Steel FRP Material	\$ 760.53	\$ 1,438,728 \$ 332,346 \$ 1,598,316	Process Ventilation (F) provided.	External hydrants plus foam deluge water spray system.
10.	Incinerator Receiving Tanks • Building • Storage Tanks	25x30 3.6 Dia. x 4.0H	750 Volume (M ³) 40.5	Walls and roof constructed of insulated panels. Carbon Steel	\$ 761.10	\$ 570,823 \$ 193,200	Tanks to be provided with Process Ventilation (E).	External hydrants plus foam deluge water spray system.
11.	Maintenance Shops, Stores including Garage for emergency vehicles. • Washrooms • Offices • Stores • Garage	25x55x5.5H	1375	Walls and roof constructed of insulated panels.	\$ 760.53	\$ 1,045,731	Heating provided by forced Air (Heat Recovery from Incinerator) System (A). Heating and Cooling for office provided by Water to Air System, Direct Discharge (D). General Ventilation (F) provided.	External hydrant plus sprinkler system.

TABLE C.4 OPERATING AREA INFORMATION FOR TAX ASSIGNMENT PURPOSES
300 000 t/a CAPACITY

BLANK NO.	DESCRIPTION OF BUILDINGS	SIZE (M)	AREA (M ²)	CONSTRUCTION	\$/SM	ESTIMATED COST	DESCRIPTION OF HVAC SYSTEM (SEE ATTACHED NOTES)	DESCRIPTION OF FIRE FIGHTING SYSTEM
14.	Truck Wash Station • Building • Concrete Basement	15 x 25 x 6H N/A	375 N/A	Walls and roof constructed of insulated panels.	\$ 551.11	\$ 158,926 \$ 47,740	Heating provided by forced air (Heat Recovery from Incinerator) System (A). Process Ventilation (E) provided.	External hydrants plus deluge water spray system for each truck wash bay.
19.	Auxiliary Boiler and Feedwater Treatment	12 x 32 x 14H	384	Wall and roof constructed of insulated panels	\$ 913.55	\$ 350,802	Heating provided by forced air (Heat Recovery from Incinerator) System (A) General Ventilation (F) provided	Standpipe and hose pipe to be located in this area.
20.	Stack • Outer Shell • Two (2) Liners	100 M 4.55 I/D 1.3 Dia.	N/A	Concrete Carbon Steel		\$ 1,386,800	N/A	External Hydrants.
22.	Drum Handling and Storage	90 x 82 x 6H	7380	Walls and roof constructed of insulated panels	\$ 763.77	\$ 5,636,658	Heating provided by forced air (Heat Recovery from Incinerator) System (A) and Energy Recovery from Process Extract System (B). Heating and cooling for office and Control Room provided by Water to Air System, Direct Discharge (D), Process Ventilation (E) and General Ventilation (F) provided.	External hydrant plus foam deluge water spray for areas storing organic waste. External hydrants plus sprinklers for areas storing inorganic wastes. Operating room in organic processing area and control room in organic processing area shall be protected by a portable Halon system.
25.	Administration Offices: First Floor: • Showers, washroom and locker area • Lunch Room • Central Monitoring Room • Computer Room • Laboratories • Control Lab • Truckers Amenities • Conference Rooms • General Offices • Foyer/Reception Area • Storage and Delivery Area	23x100x7.7H	2550	Formal walls on a concrete structure i.e. Frame, pillars, roof and floor form concrete structure. Insulated panels form walls.	\$ 1453.42	\$ 3,633,540	Heating provided indirectly from incinerator and air conditioning from steam operated absorption chillers (C). Process Ventilation (E) and General Ventilation (F) provided.	External hydrants provided. Central monitoring facilities and computer room to be protected by a fixed Halon system. Amenities areas to be protected by sprinkler system. Associated offices, conference room etc., to be protected by standpipe and Hose System.

TABLE C.4 OPERATING AREA INFORMATION FOR TAX ASSESSMENT PURPOSES
300 000 c/a CAPACITY

BLOCK NO.	DESCRIPTION OF BUILDINGS	SIZE (M)	AREA (M ²)	CONSTRUCTION	S/SN	ESTIMATED COST	DESCRIPTION OF HVAC SYSTEM (SEE ATTACHED NOTES)	DESCRIPTION OF FIRE FIGHTING SYSTEM
25. Cont'd	Administration Offices (Cont'd) • Second Floor: • General Offices • Conference Rooms • Storage Rooms • Washrooms • Lunch Room	--	--	--	--	--	--	Laboratories to be protected by portable Halon System and standpipe and hose stations.
26.	Car Park (paved area)	--	4200	--	\$ 37.51	\$ 157,535	--	External Hydrants
27.	Gatehouse and Neighbourhood Building • Neighbourhood • Washrooms	3 x 30 x 3H N/A	90 N/A	Walls and roof constructed of insulated panels.	\$ 460.00	\$ 41,400 \$ 126,960	Heating and air-conditioning provided by electric heating and packaged air-conditioning units. General Ventilation (F) provided.	External Hydrants
28.	Emergency Power Generation	20x23x4.25H	460	3 walls - insulated panels 1 wall - brick Roof - built up roof of asphalt and gravel	\$ 760.53	\$ 349,845	Steam Unit Heating and General Ventilation (F) provided.	External Hydrants
29.	Main Substation Building	20x25x4.25H	500	3 walls - insulated panels 1 wall - brick Roof - built up roof of asphalt and gravel	\$ 760.53	\$ 380,266	Heating and cooling provided by Water to Air System, Direct Discharge (D). General Ventilation (F) provided.	Internal Hydrants Firewalls separating Main Transformers from each other and Block No. 28 will be provided.
35.	Truck Holding Area (paved area)	--	3000	--	\$ 37.51	\$ 112,525	--	External Hydrant.

**TABLE C.4 OPERATING AREA INFORMATION FOR TAX ASSESSMENT PURPOSES
300 000 t/a CAPACITY**

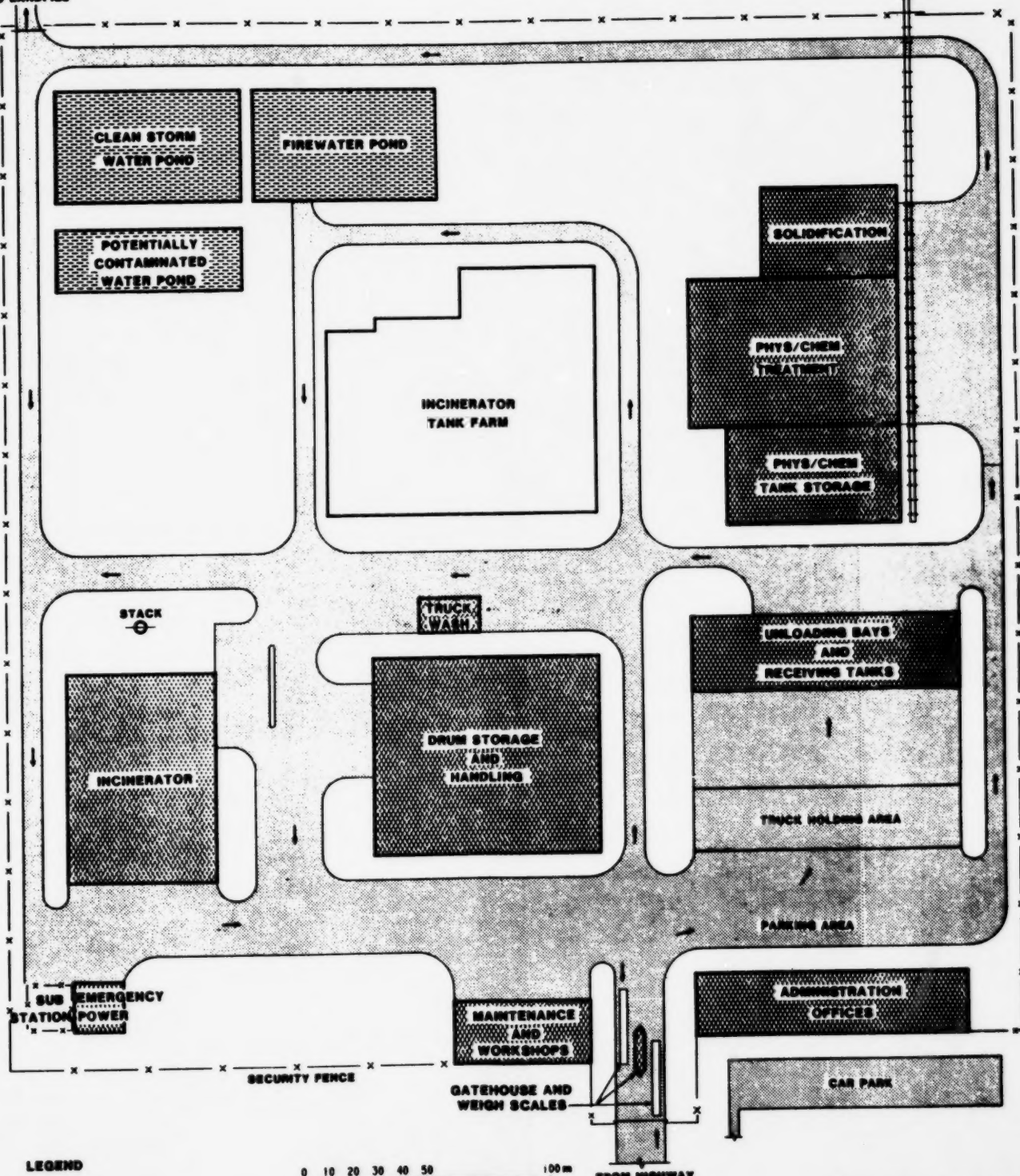
NOTES: 1. Definition of HVAC services area as follows:

- A = Outside air heated by energy recovery (where applicable) and Glycol/Water Coil indirectly served by steam from incinerator, plus steam unit heater for local control.
- B = Heat energy recovery by run-a-round system between process/general extract and forced air heating system (A).
- C = Full air-conditioning, heat indirect from incinerator and cooling from steam operated absorption chiller.
- D = Semi air-conditioning, (heating and cooling only) heating re-circulated plus outside, indirect from incinerator, cooling from central systems. Forced air delivery.
- E = Process Ventilation - i.e. extract from process areas and or equipment. Also refers to closed tank extract.
- F = Generally roof exhaust fans, washroom ventilation, etc.

APPENDIX D
MAP PORTFOLIO

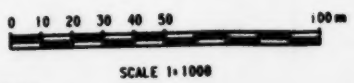
ACCESS ROAD
TO LANDFILL

RAIL SPUR



LEGEND

-  BUILDINGS
-  PAVED AREA
-  TRAFFIC FLOW



NOTES:

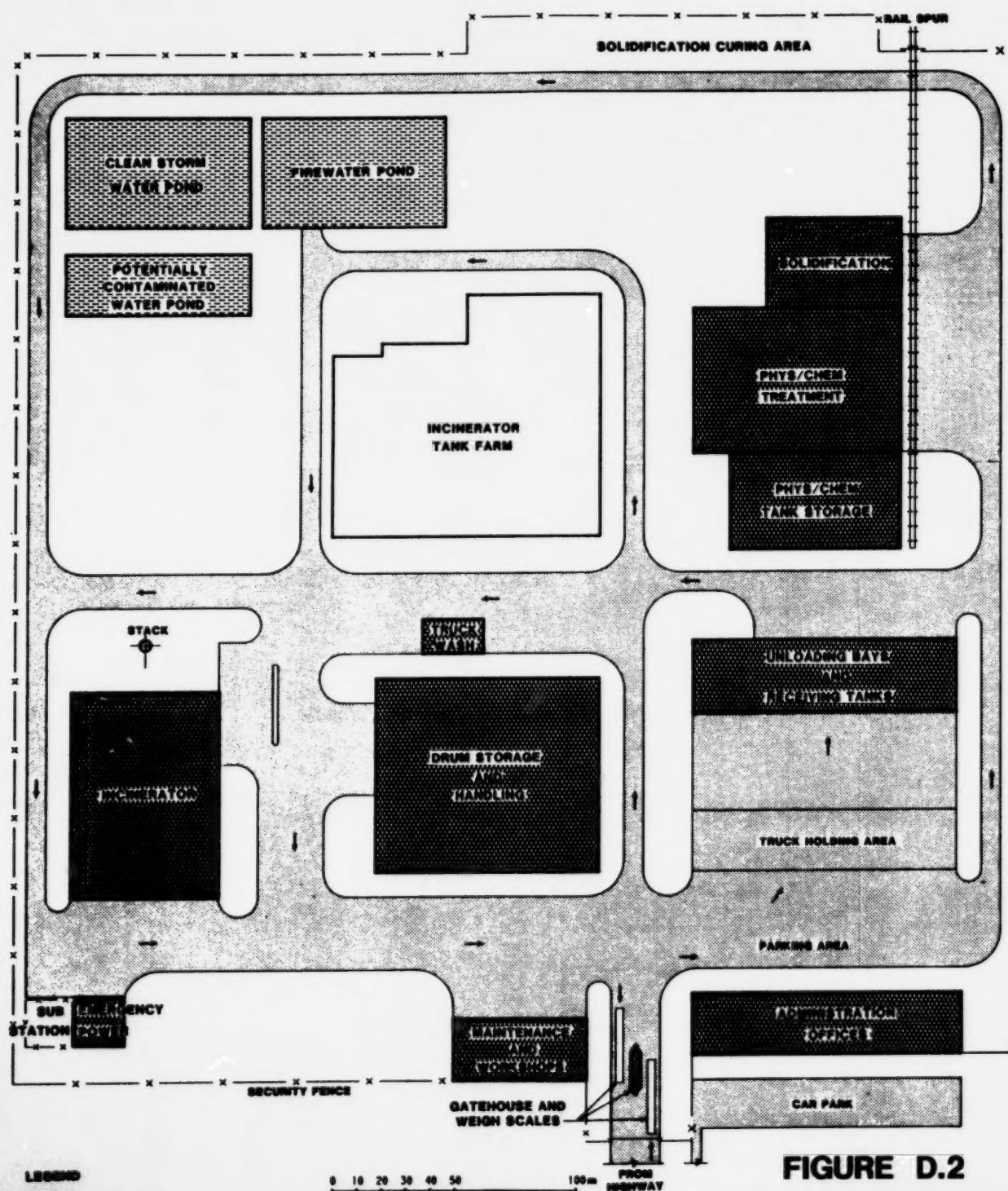
1. MAINTENANCE AND ADMINISTRATION BUILDINGS, GATEHOUSE AND CARPARK WILL BE LOCATED TO GIVE PREPARED ACCESS ROAD

FIGURE D.1

LAYOUT OF OPERATING AREA

300 000 t/a CAPACITY

CASE 1 - INTEGRATED FACILITY



SOLIDIFICATION CURING AREA

RAIL SPUR

CLEAN STORM
WATER POND

FIREWATER POND

POTENTIALLY
CONTAMINATED
WATER POND

INCINERATOR
TANK FARM

SOLIDIFICATION

PHYS/CHEM
TREATMENT

PHYS/CHEM
TANK STORAGE

STACK

STACK

DRUM STORAGE
AND
HANDLING

UNLOADING BAY
FOR
1/4 TON TANKS

TRUCK HOLDING AREA

PARKING AREA

SUB
STATION

SECURITY FENCE

GATEHOUSE AND
WEIGH SCALES

MAINTENANCE
BUILDING

CAR PARK

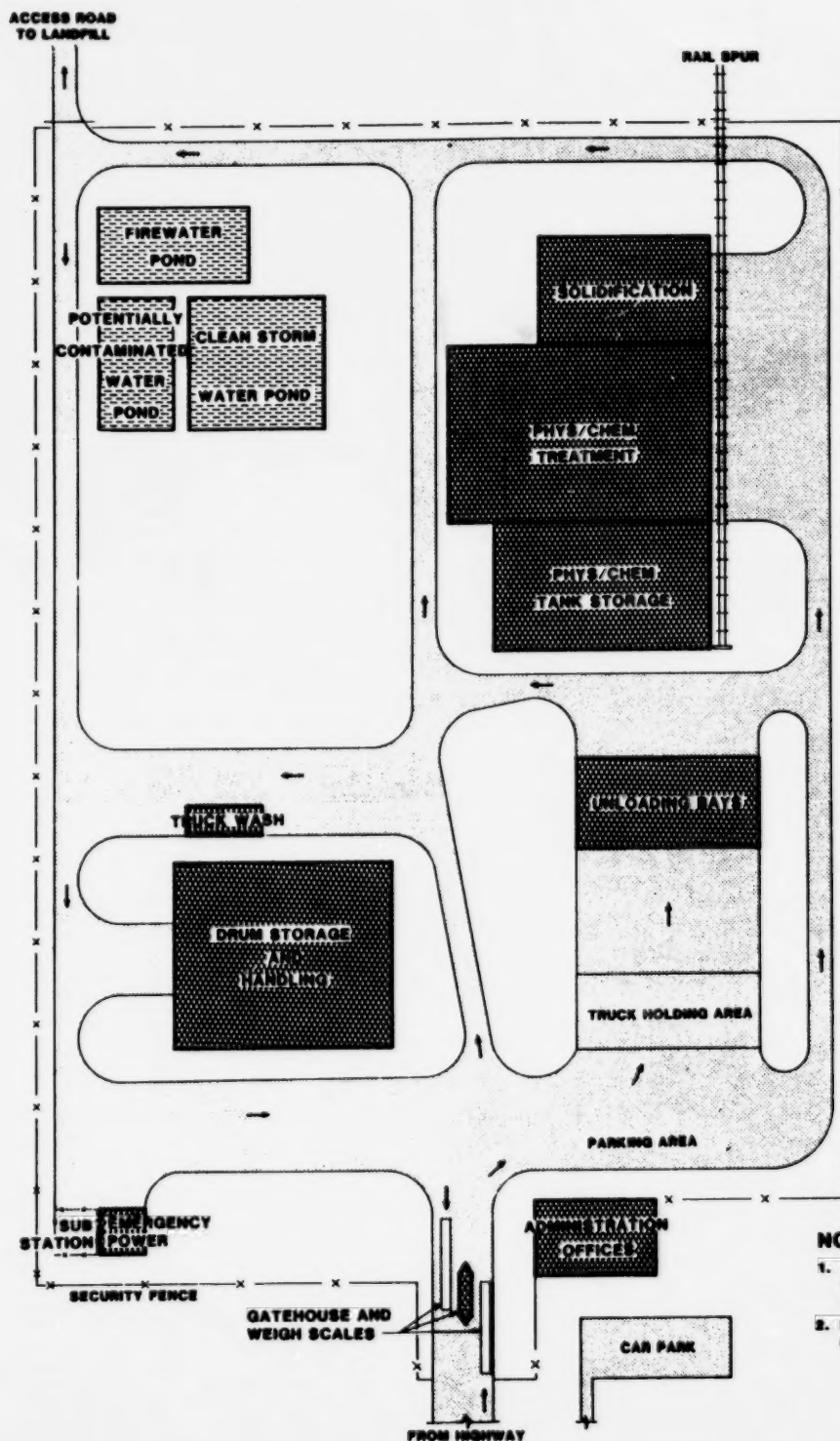
FIGURE D.2

LAYOUT OF OPERATING AREA

300 000 t/a CAPACITY

CASE 2 - LANDFILL SEPARATE

PHYSICAL/CHEMICAL/INCINERATION FACILITY



NOTES:

1. ADMINISTRATION OFFICES, GATEHOUSE AND CARPARK WILL BE LOCATED TO SUIT PREFERRED ACCESS ROAD
2. FOR ORIENTATION OF FACILITY SEE SITE LAYOUT OF SPECIFIC SITING OPTION

LEGEND

-  BUILDINGS
-  PAVED AREA
-  TRAFFIC FLOW

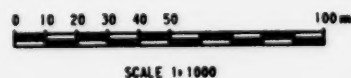
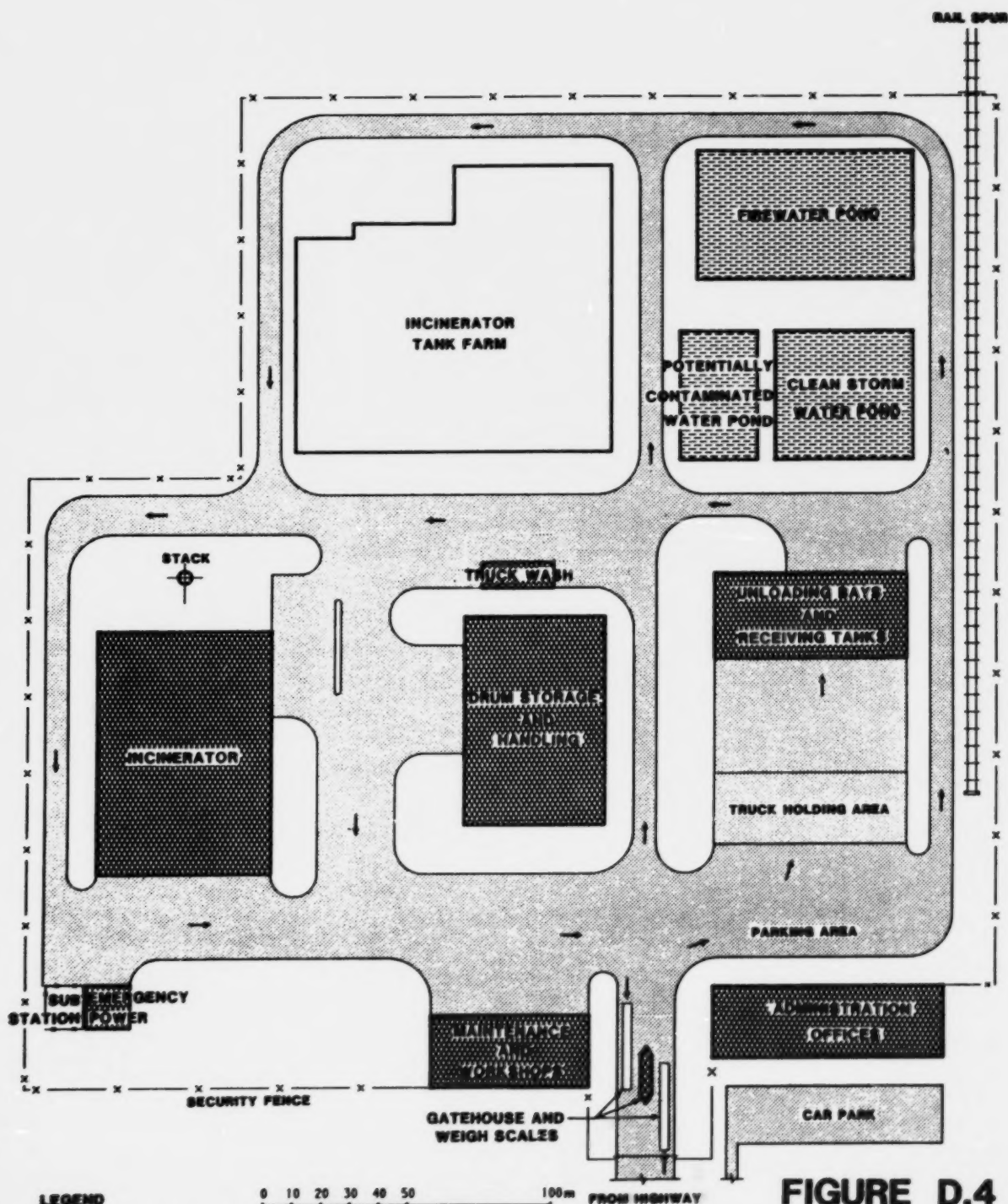


FIGURE D.3

**LAYOUT OF OPERATING AREA
300 000 t/a CAPACITY**

**CASE 3 - INCINERATOR SEPARATE
PHYSICAL/CHEMICAL/LANDFILL FACILITY**



LEGEND



BUILDINGS



PAVED AREA



TRAFFIC FLOW

0 10 20 30 40 50 100m

SCALE 1:1000

NOTES:

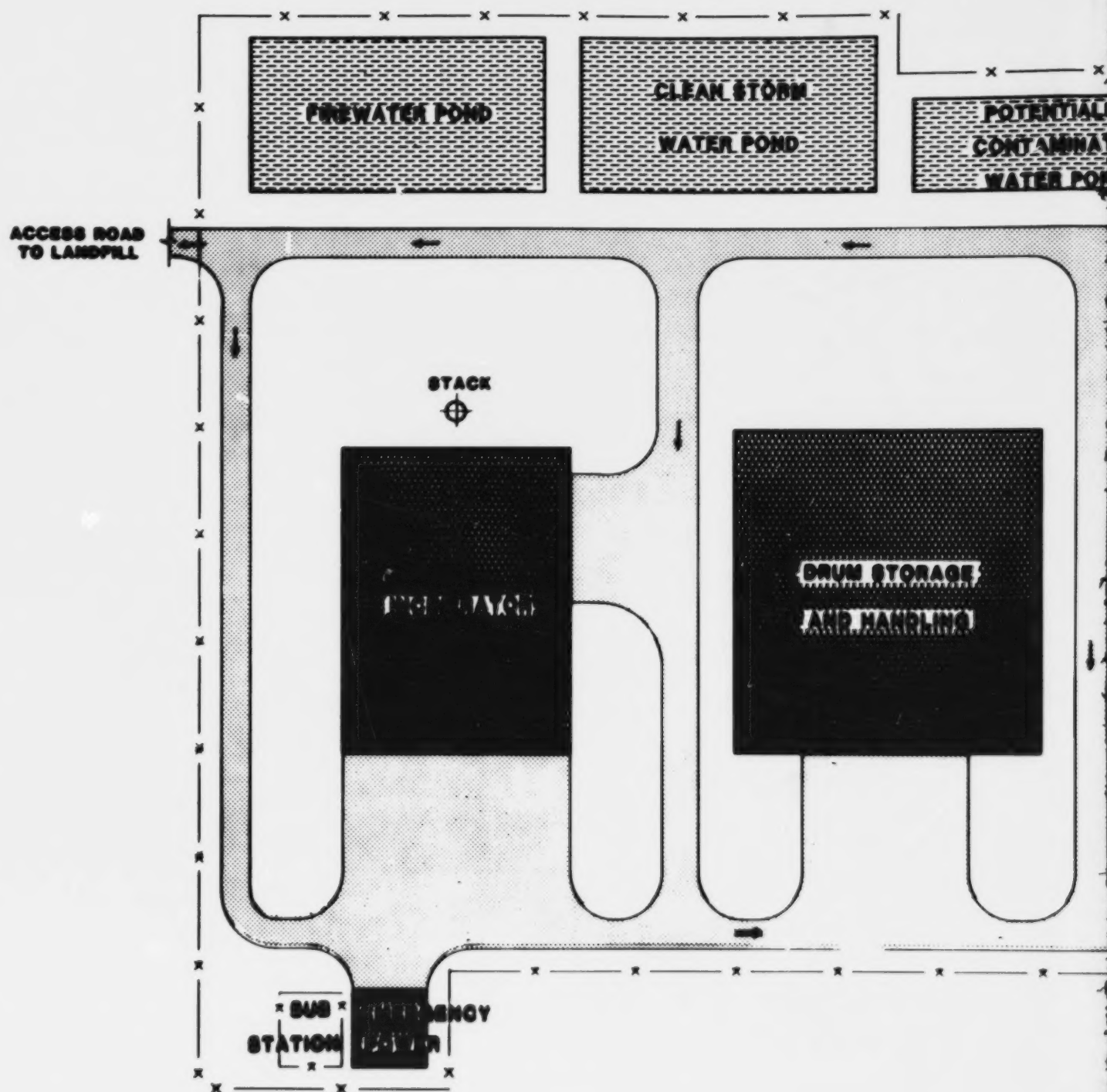
1. MAINTENANCE AND ADMINISTRATION BUILDINGS, GATEHOUSE AND CARPARK WILL BE LOCATED TO SUIT PREFERRED ACCESS ROAD
2. FOR ORIENTATION OF FACILITY SEE SITE LAYOUT

FIGURE D.4

LAYOUT OF OPERATING AREA

300 000 t/a CAPACITY

CASE 3 - INCINERATOR SEPARATE
INCINERATION FACILITY



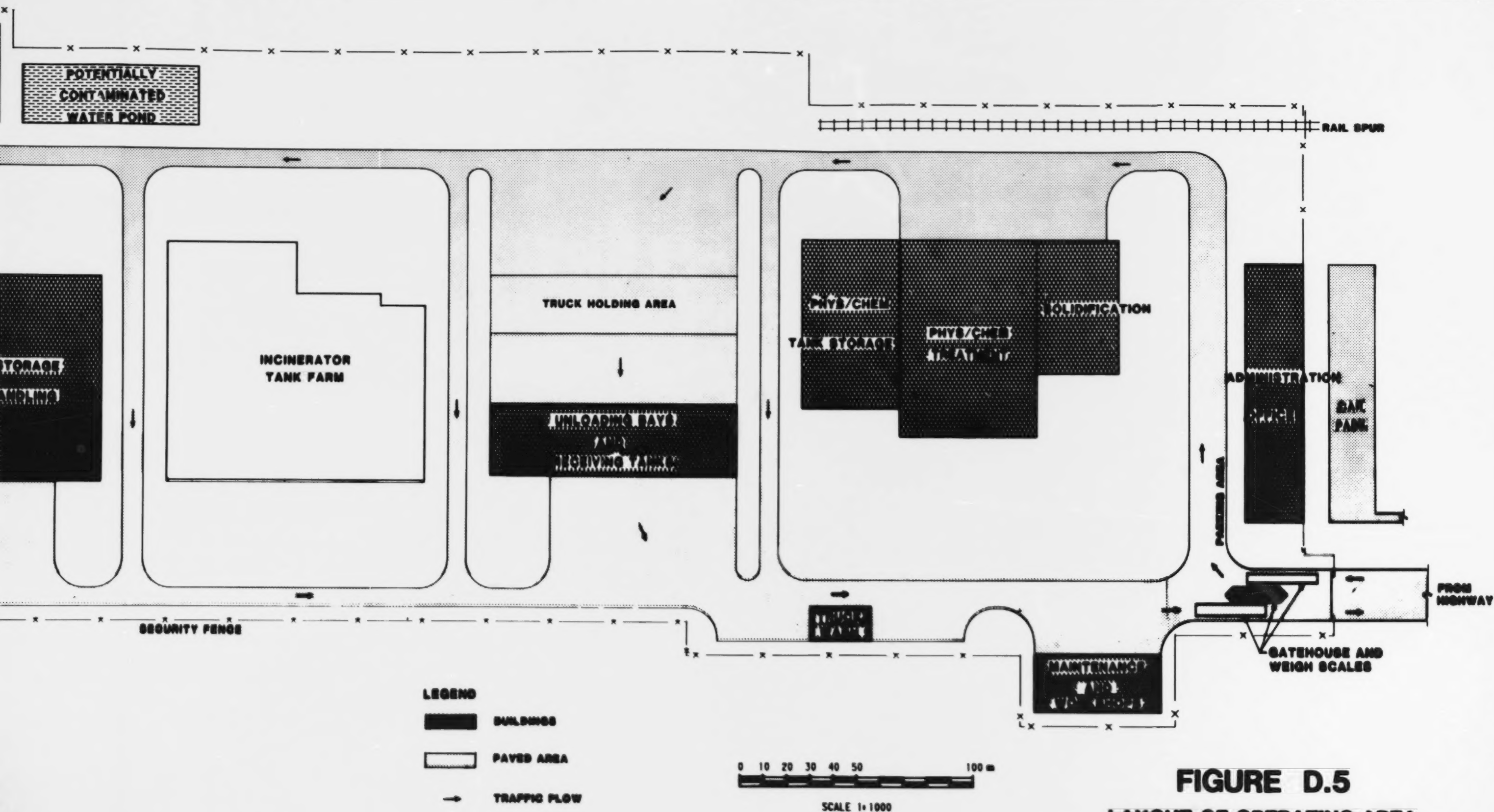


FIGURE D.5
LAYOUT OF OPERATING AREA
300 000 t/a CAPACITY
CASE 1 - INTEGRATED FACILITY
LF-9C

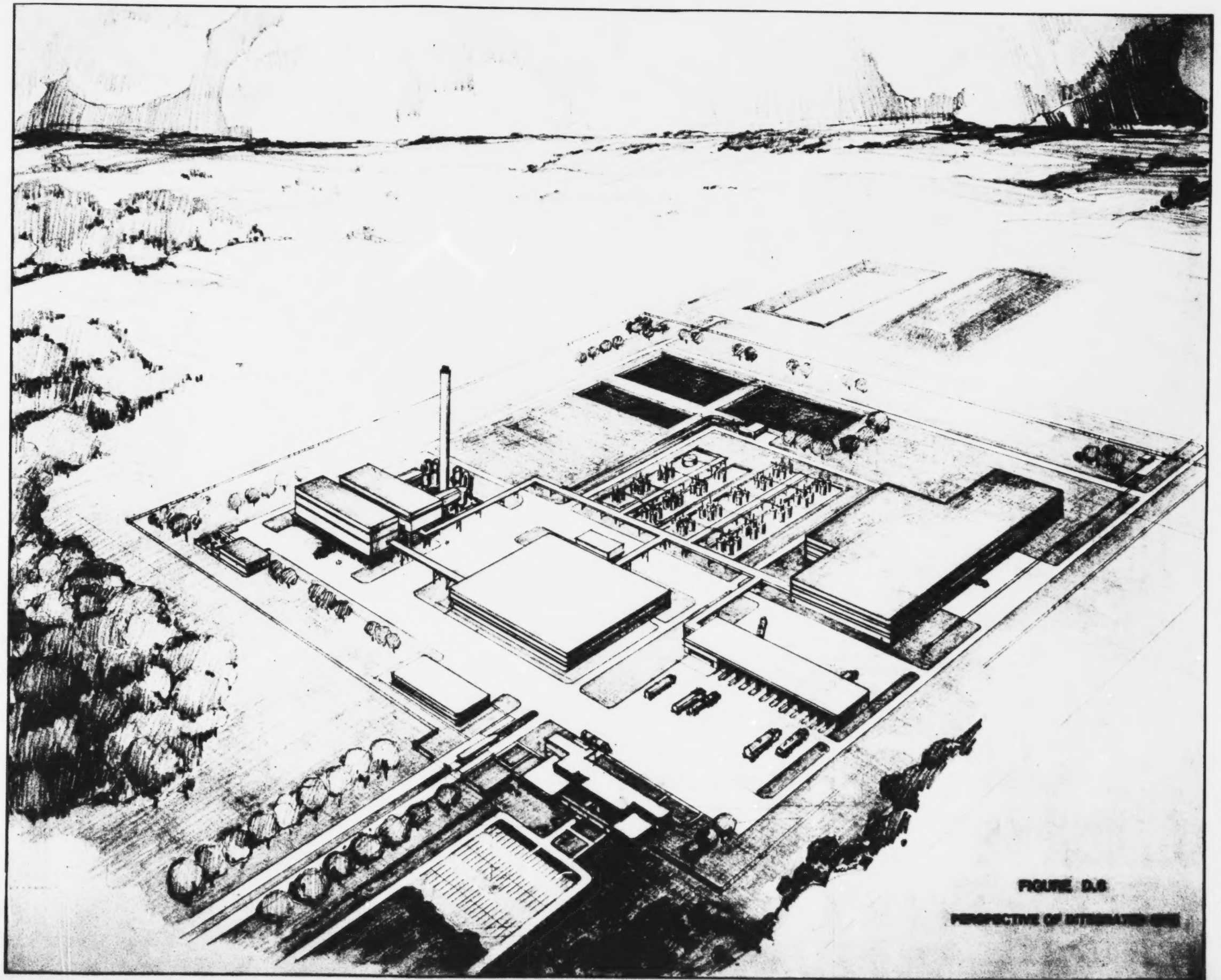


FIGURE D.6

PERSPECTIVE OF INTEGRATED ONE

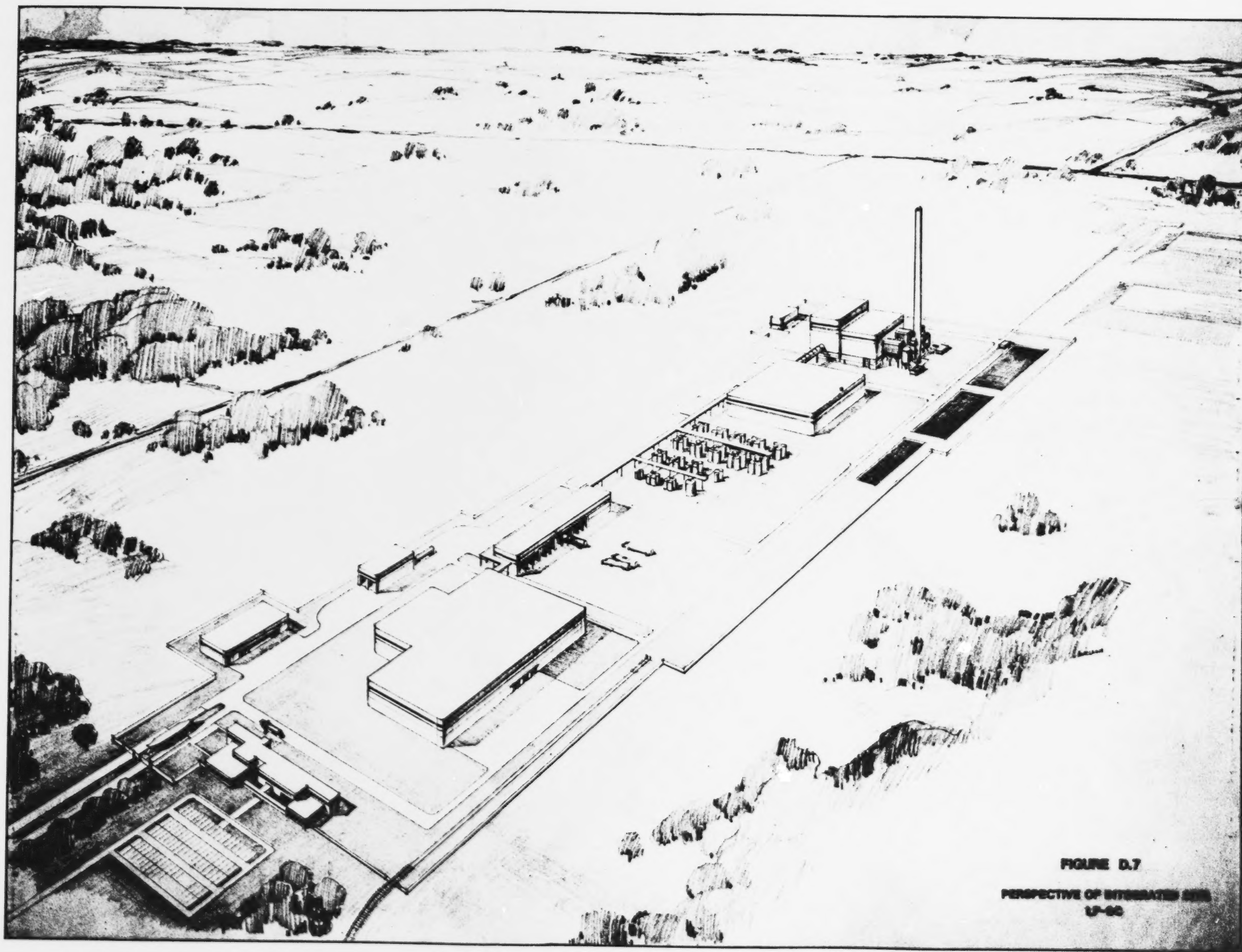
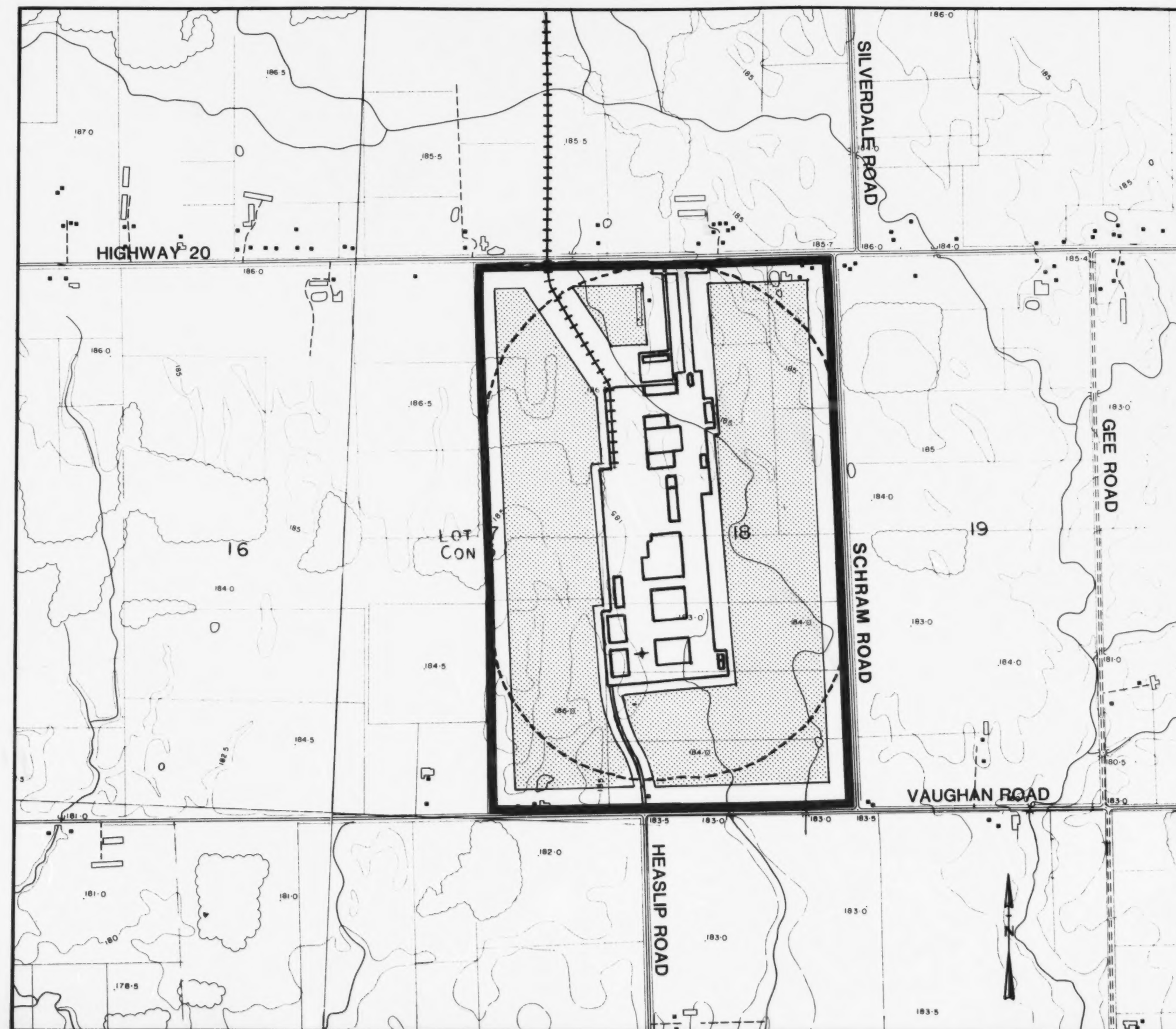


FIGURE D.7

PERSPECTIVE OF INTEGRATED SITES
LP-60



OWMC Ontario Waste Management Corporation

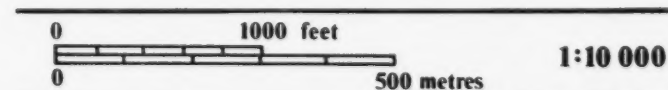
Consultant

Monenco

Legend:

LF - 9Central

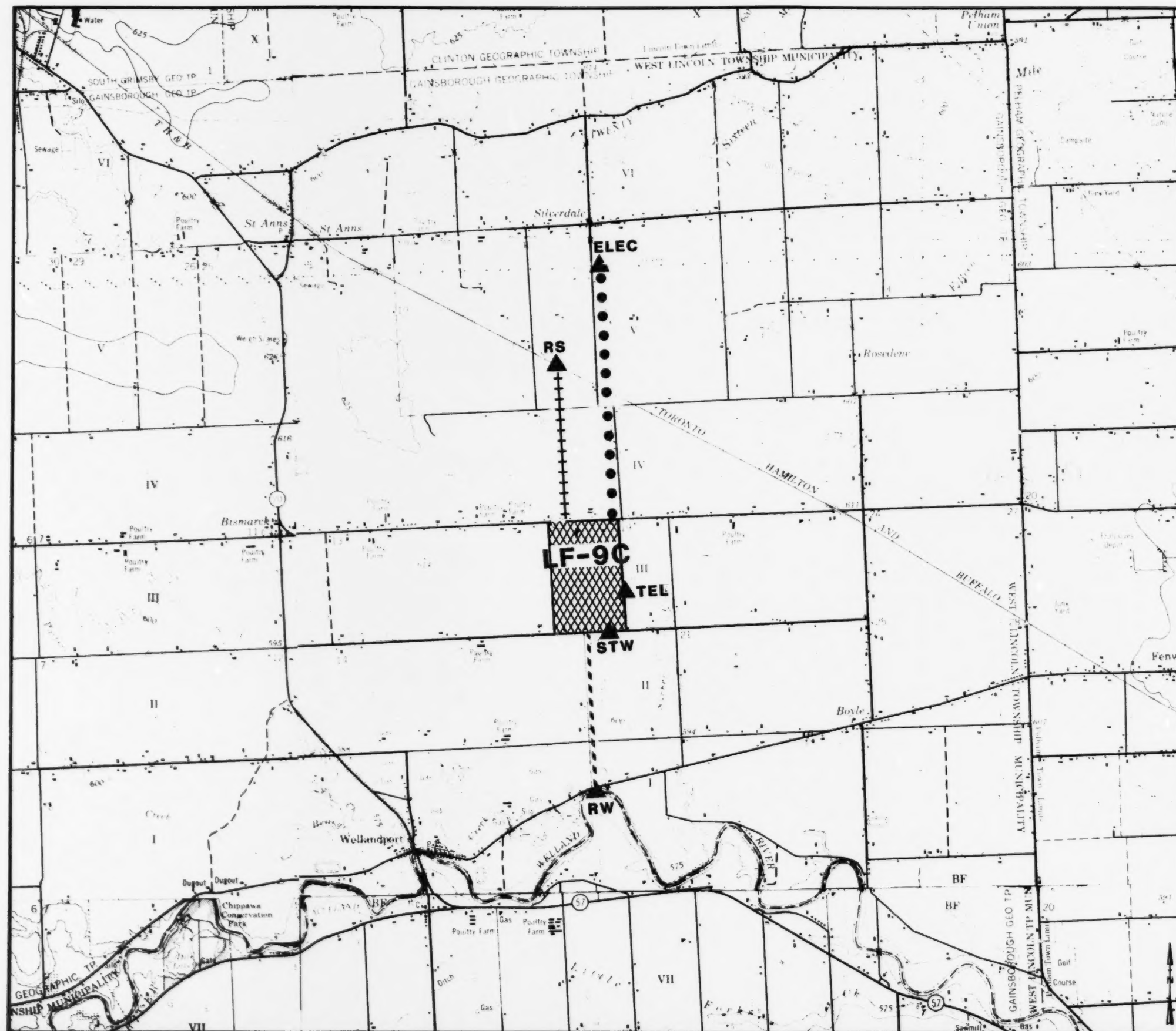
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 1-
INTEGRATED SITE
LF-9C**

December 1985

FIGURE D.8



Legend:

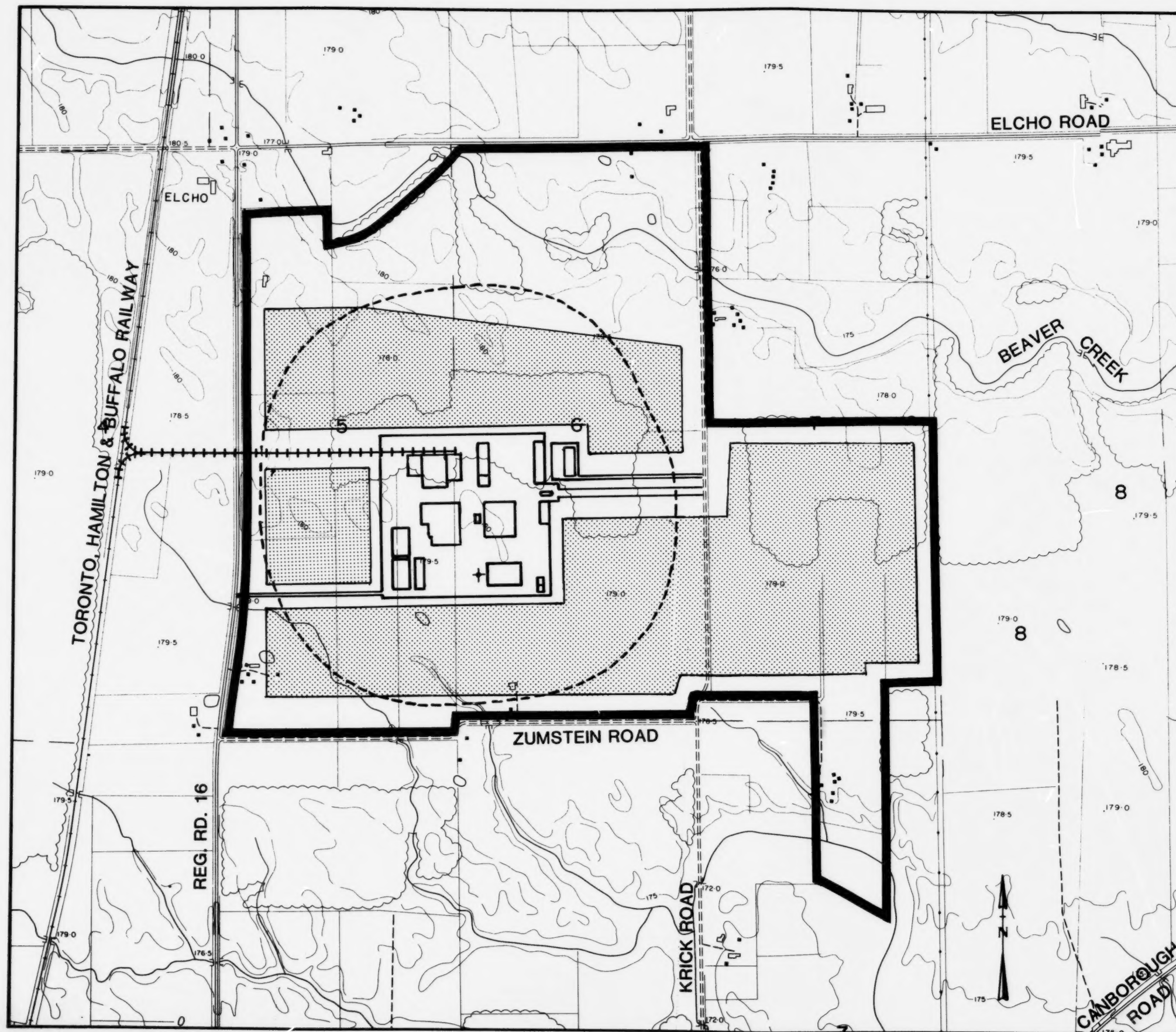
Symbol	Abbreviation	Description
---	STW	Clean Stormwater
- - - - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆ ◆ ◆ ◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1mile
0 1Kilometre
1:50 000

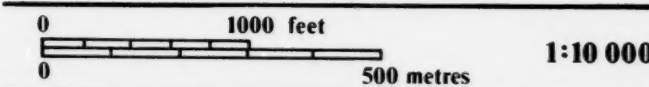
SERVICE CONNECTIONS
CASE 1-
INTEGRATED
LF-9C

December 1985

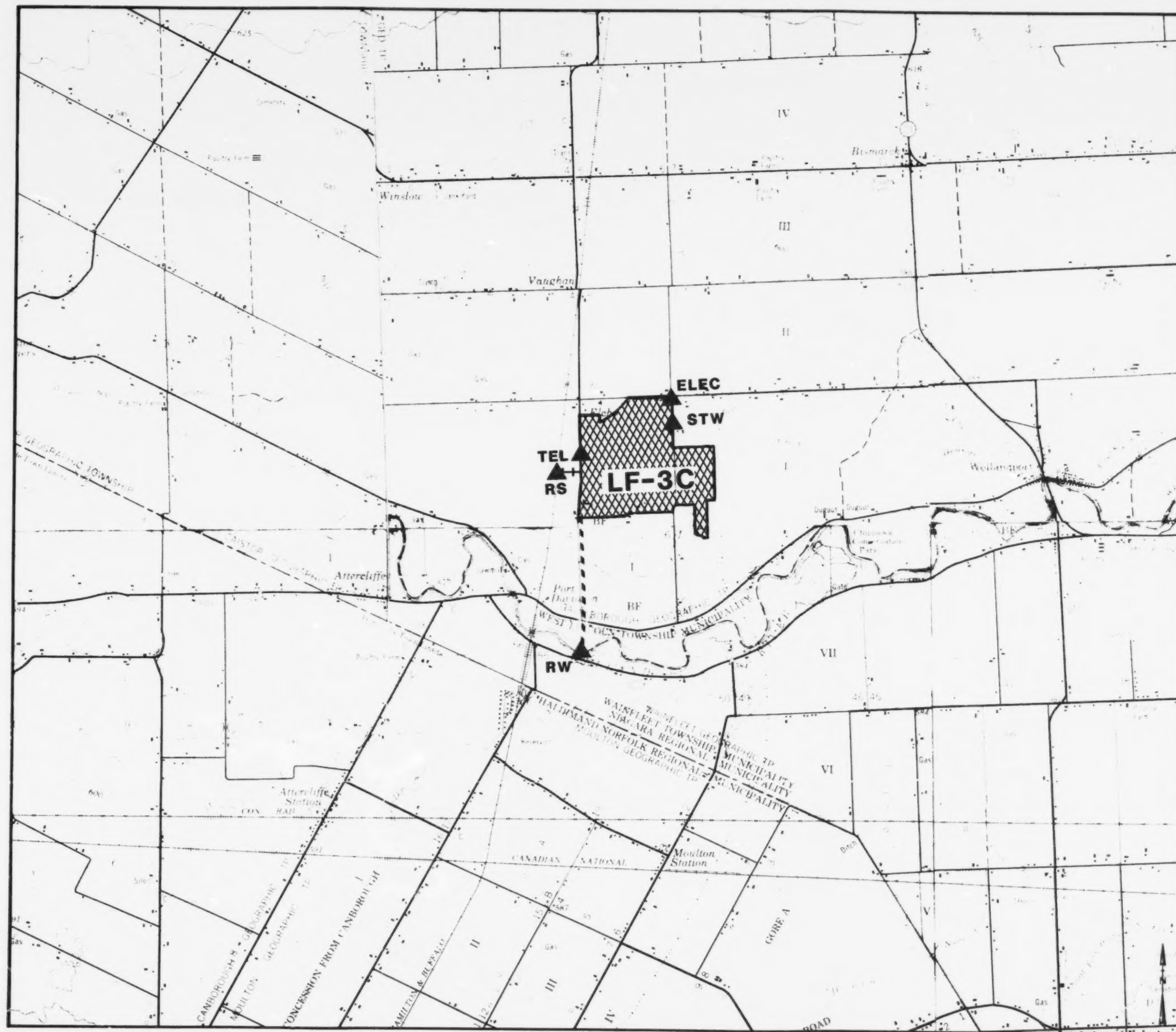
FIGURE D.9



Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



SITE LAYOUT
CASE 1-
INTEGRATED SITE
LF-3C

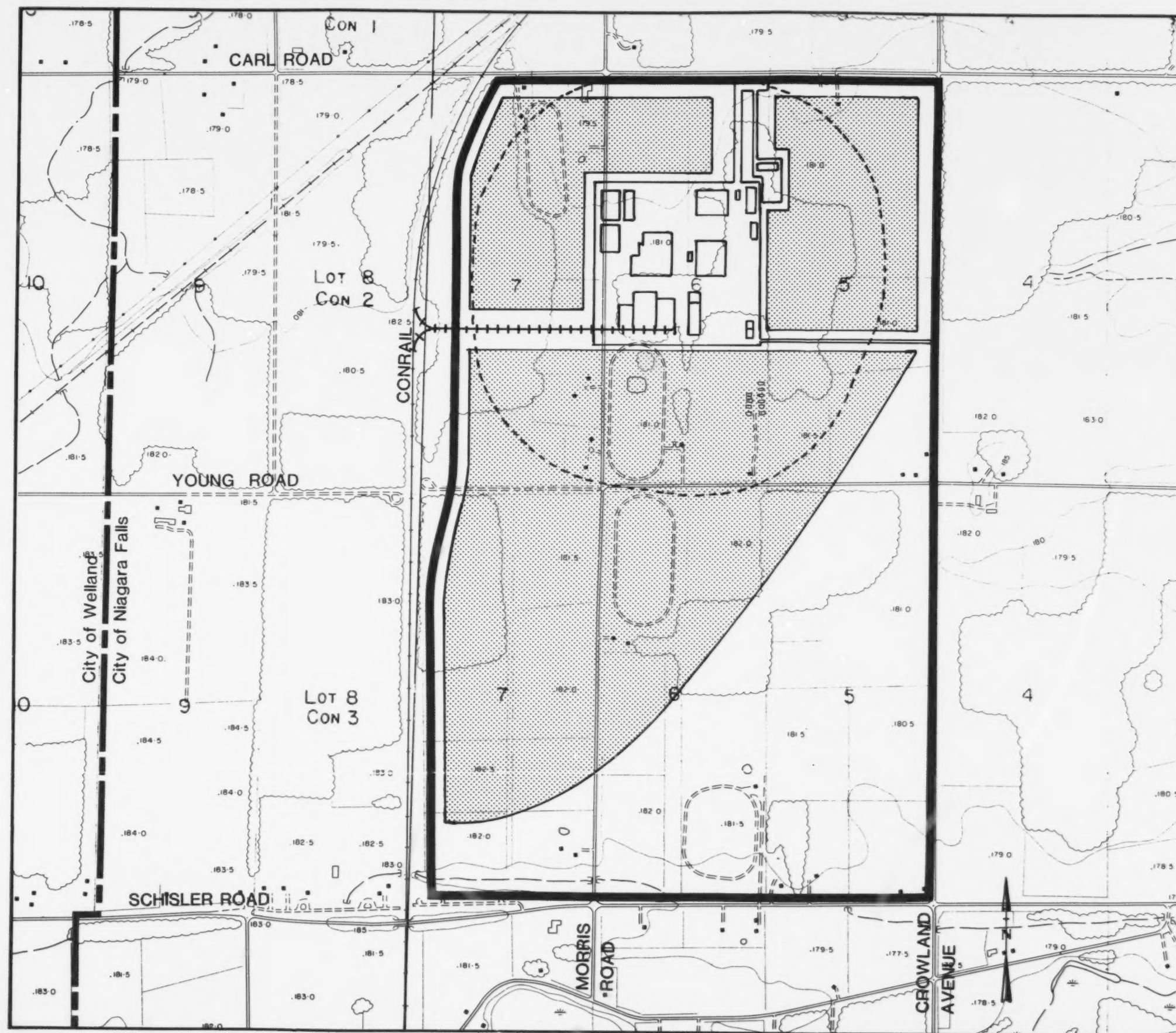


Legend:

Symbol	Abbreviation	Description
— — — — —	STW	Clean Stormwater
- - - - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆ ◆ ◆ ◆ ◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1:50 000

SERVICE CONNECTIONS
CASE 1-
INTEGRATED
LF-3C



OWMC Ontario Waste Management Corporation

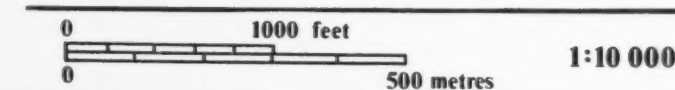
Consultant

Monenco

Legend:

LF-1East

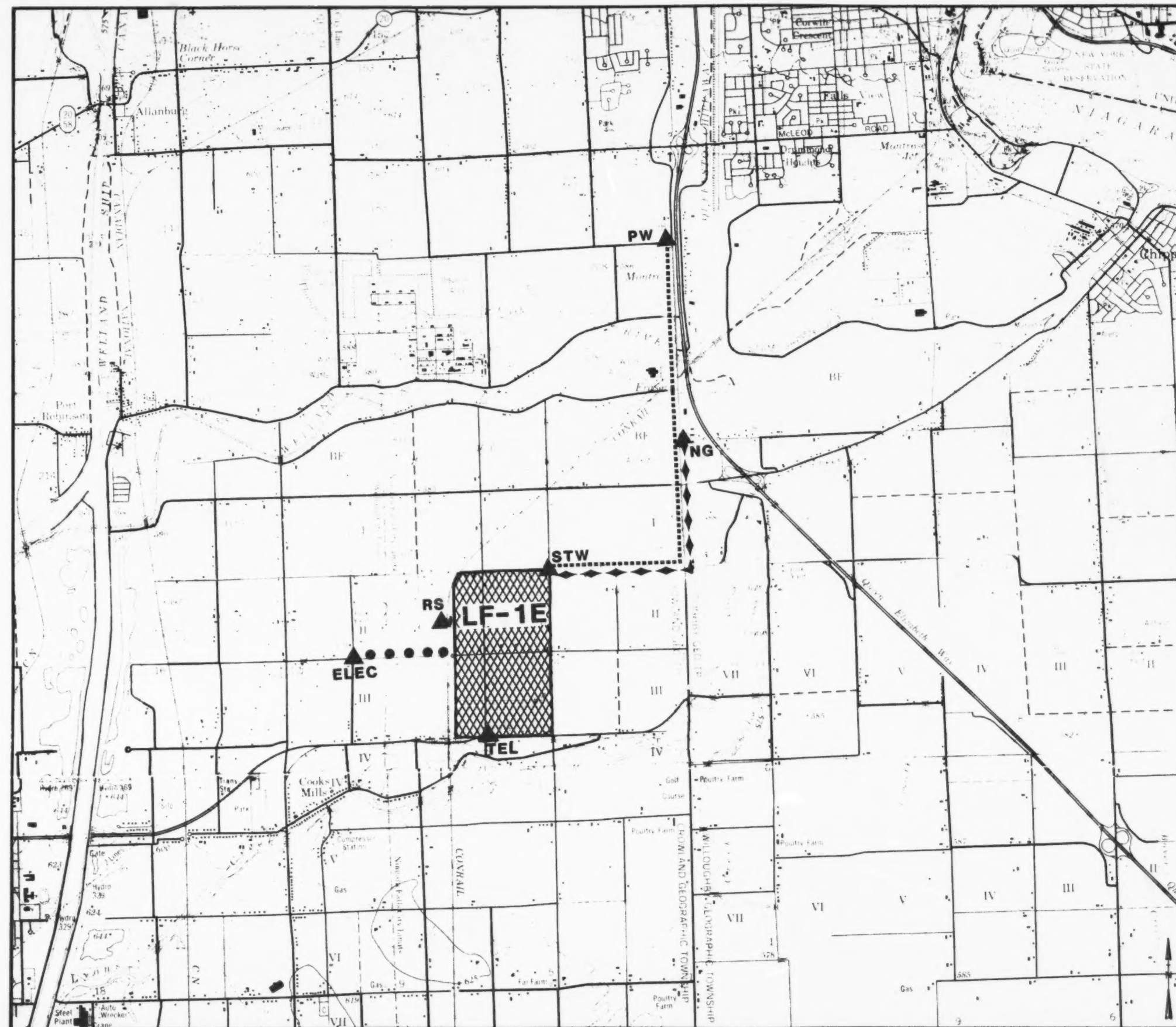
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



SITE LAYOUT
CASE 1-
INTEGRATED SITE
LF-1E

December 1985

FIGURE D.12



Legend:

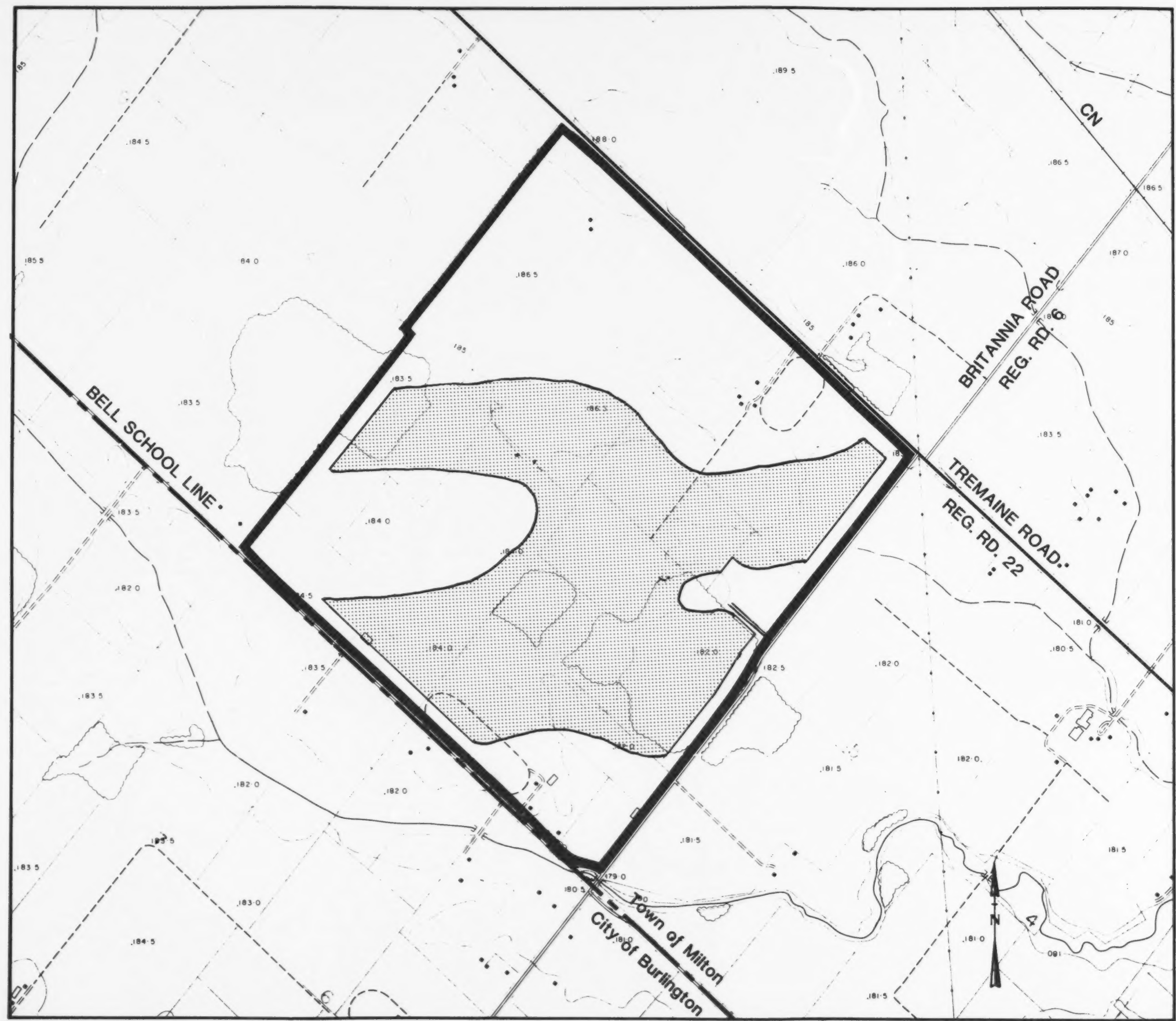
Symbol	Abbreviation	Description
---	STW	Clean Stormwater
---	RW	Raw Water Supply
---	PW	Potable Water Supply
●●●●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆◆◆◆	NG	Natural Gas Supply
+++++	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1:50 000

**SERVICE CONNECTIONS
CASE 1-
INTEGRATED
LF-1E**

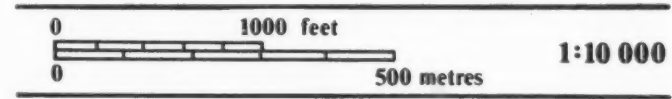
December 1985

FIGURE D.13

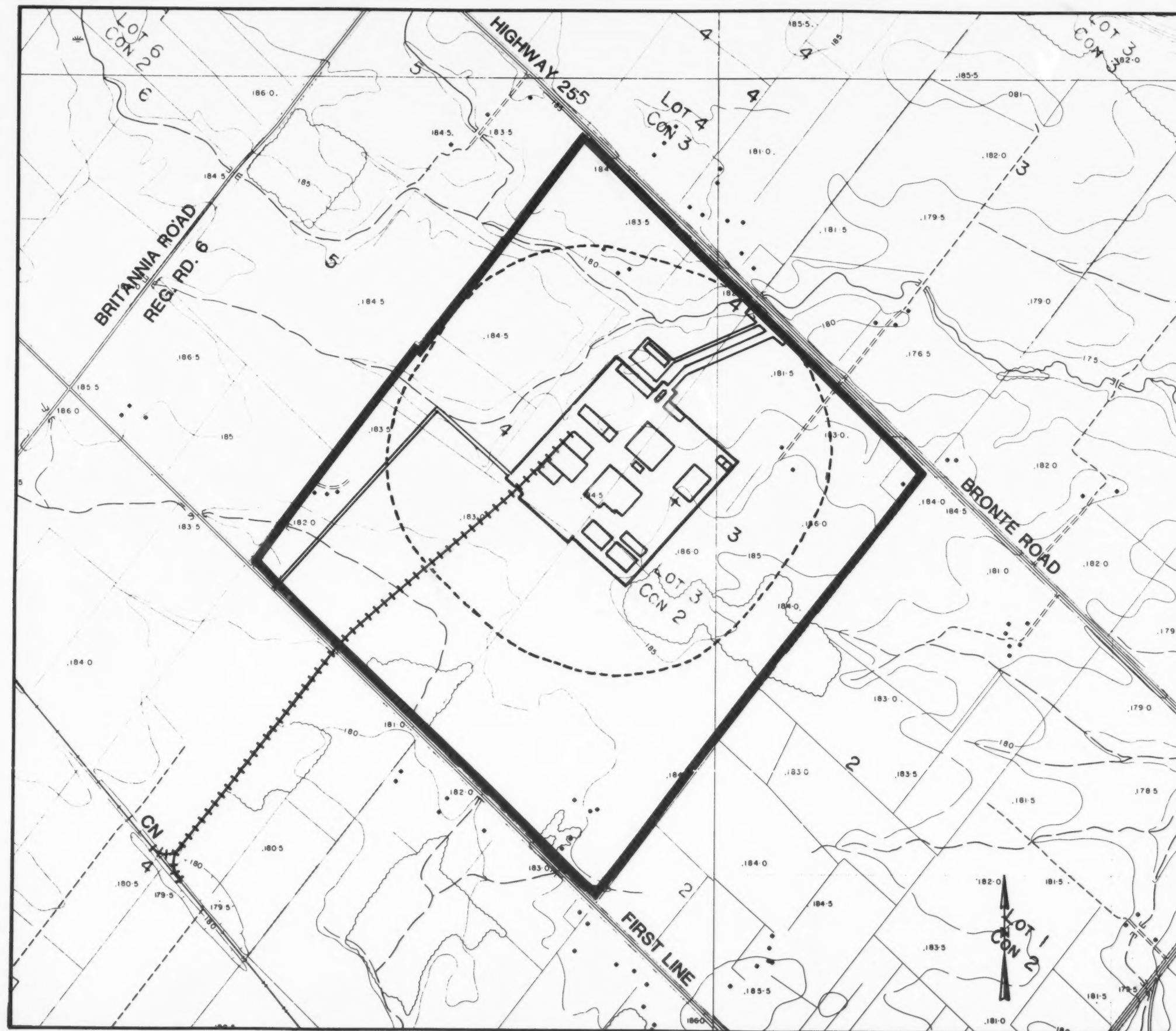


Legend: **LF - 4North**

Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
LF-4N**



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

PI-1North

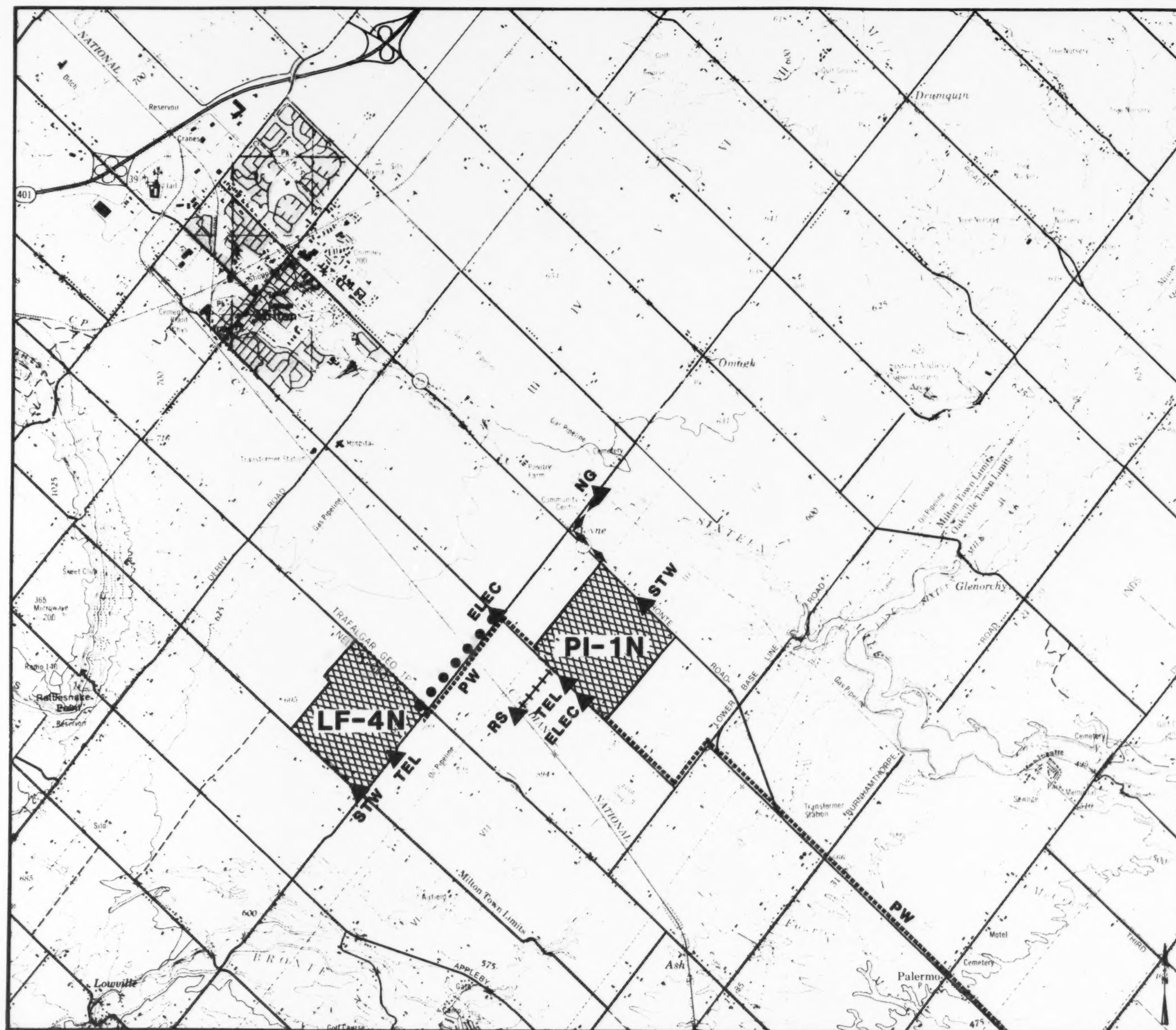
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
PI-1N**

December 1985

FIGURE D.15



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

Symbol	Abbreviation	Description
---	STW	Clean Stormwater
- - - - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆ ◆ ◆ ◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

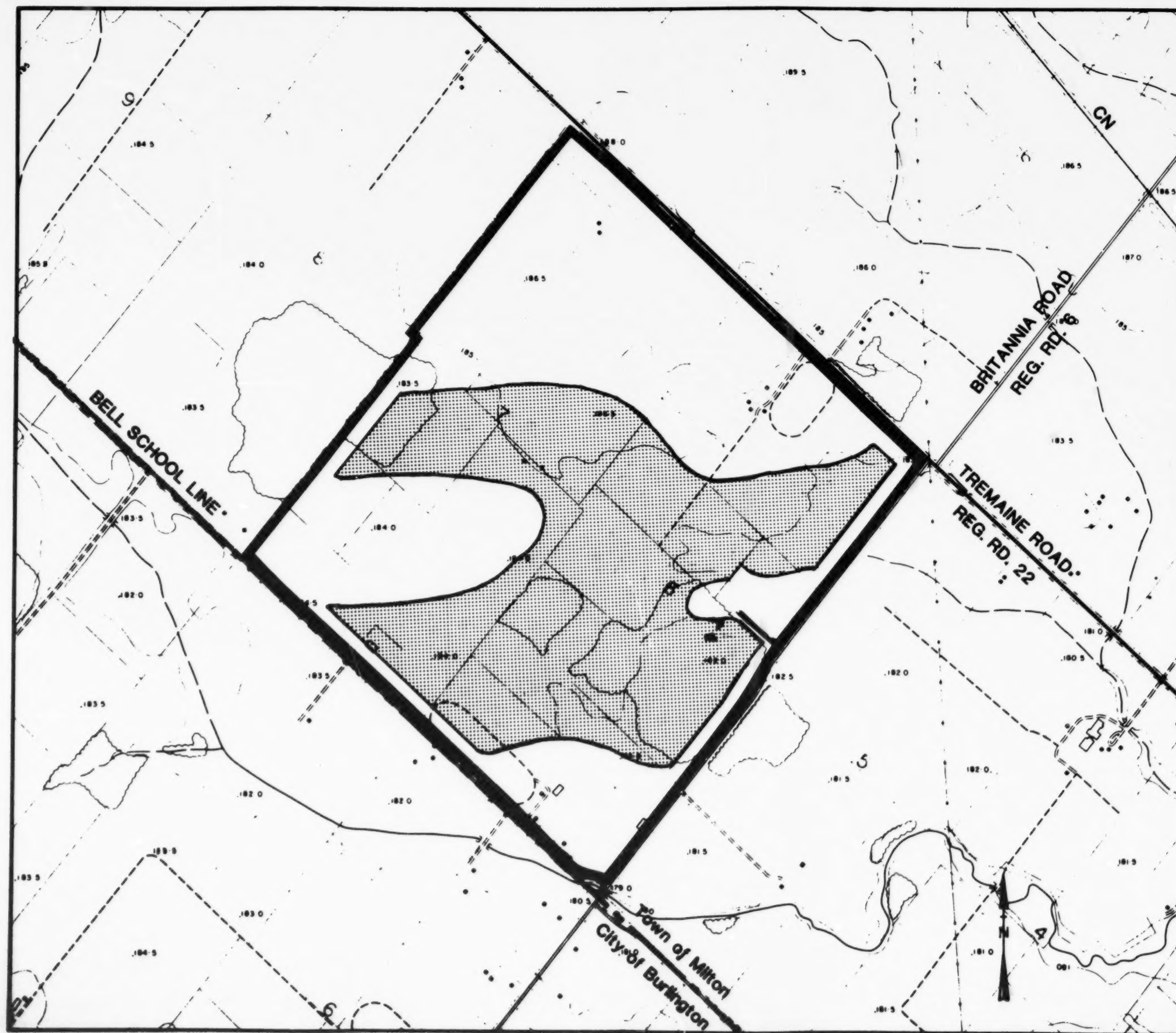
0 1mile
0 1Kilometre

1: 50 000

SERVICE CONNECTIONS CASE 2- LANDFILL SEPARATE LF-4N/PI-1N

December 1985

FIGURE D.16



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

LF - 4North

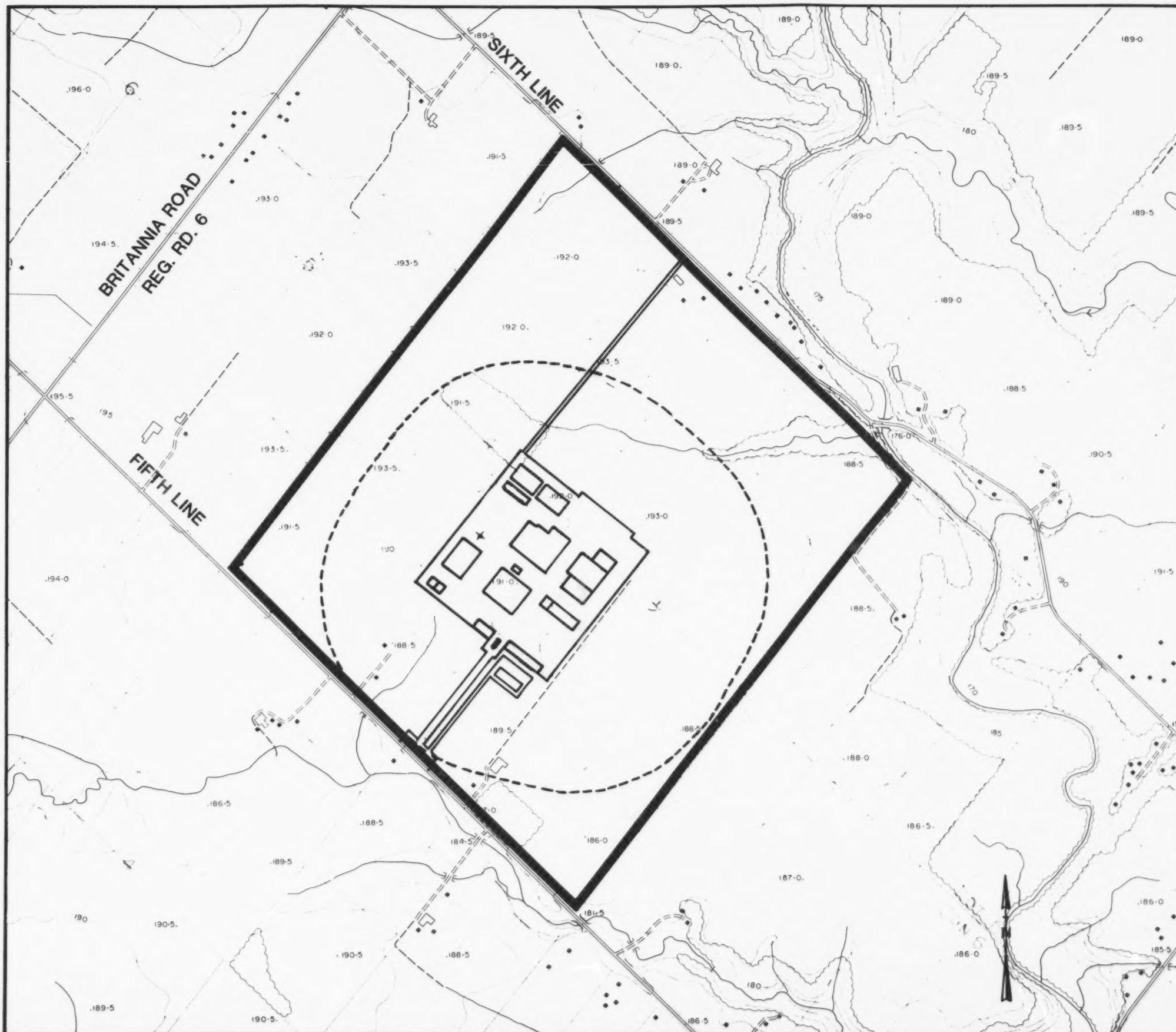
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
LF-4N**

December 1985

FIGURE D.17



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

PI-13 North

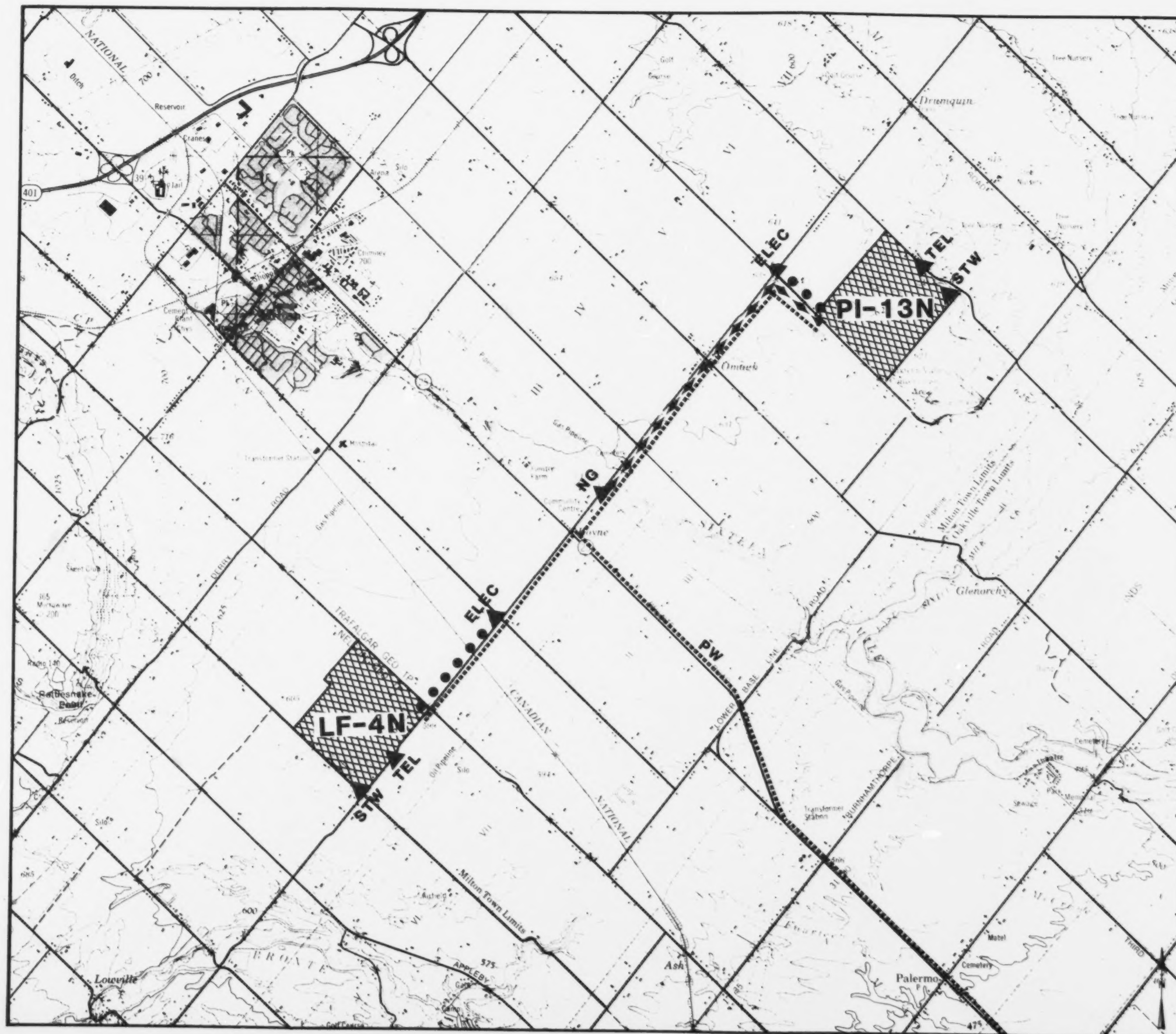
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
PI-13N**

December 1985

FIGURE D.18



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

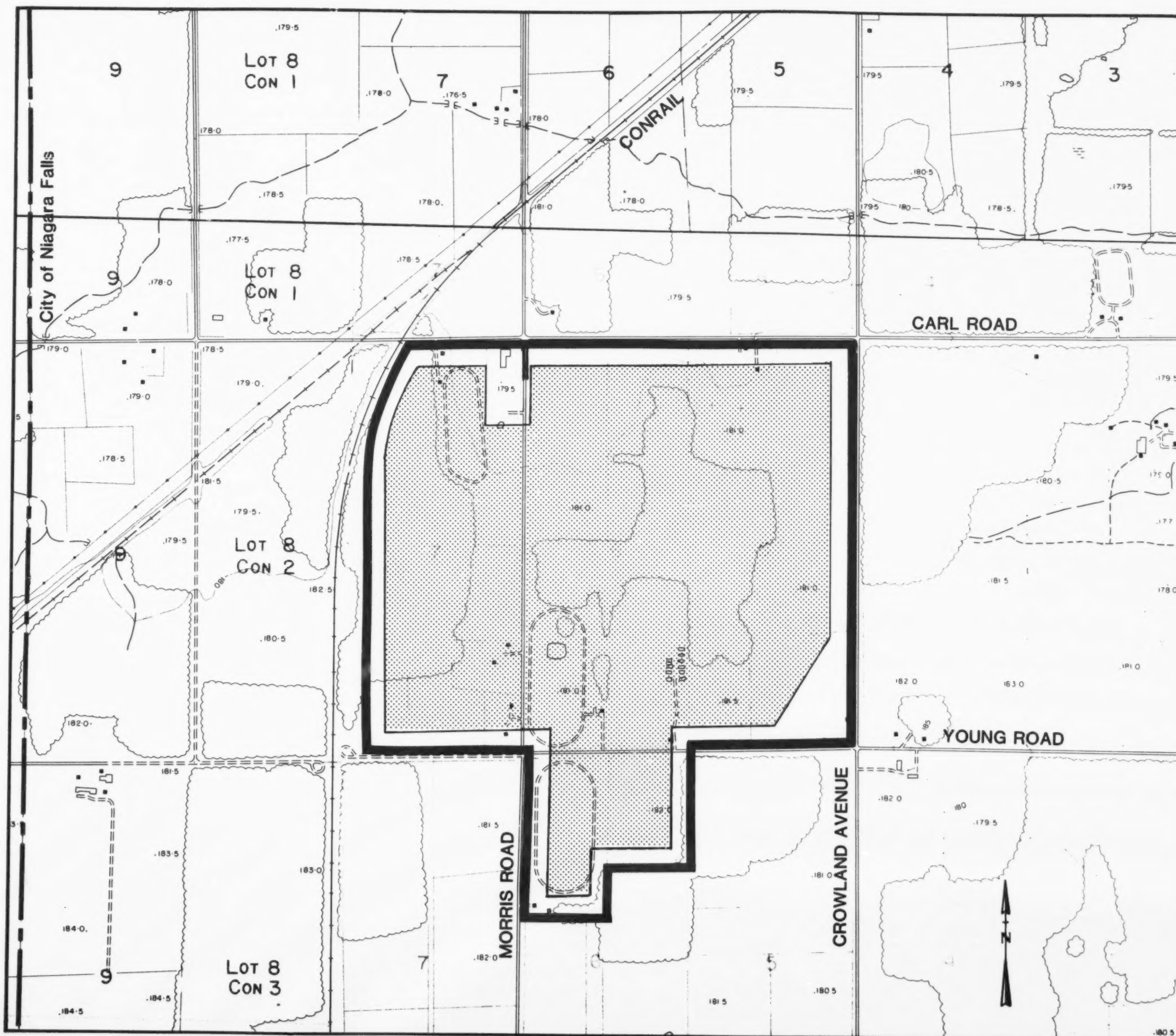
Symbol	Abbreviation	Description
---	STW	Clean Stormwater
- - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆ ◆ ◆ ◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1: 50 000

SERVICE CONNECTIONS
CASE 2-
LANDFILL SEPARATE
LF-4N/PI-13N

December 1985

FIGURE D.19



OWMC Ontario Waste Management Corporation

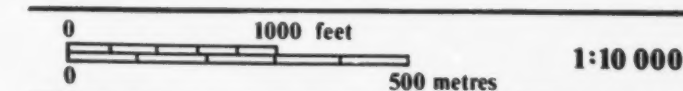
Consultant

Monenco

Legend:

LF-1East

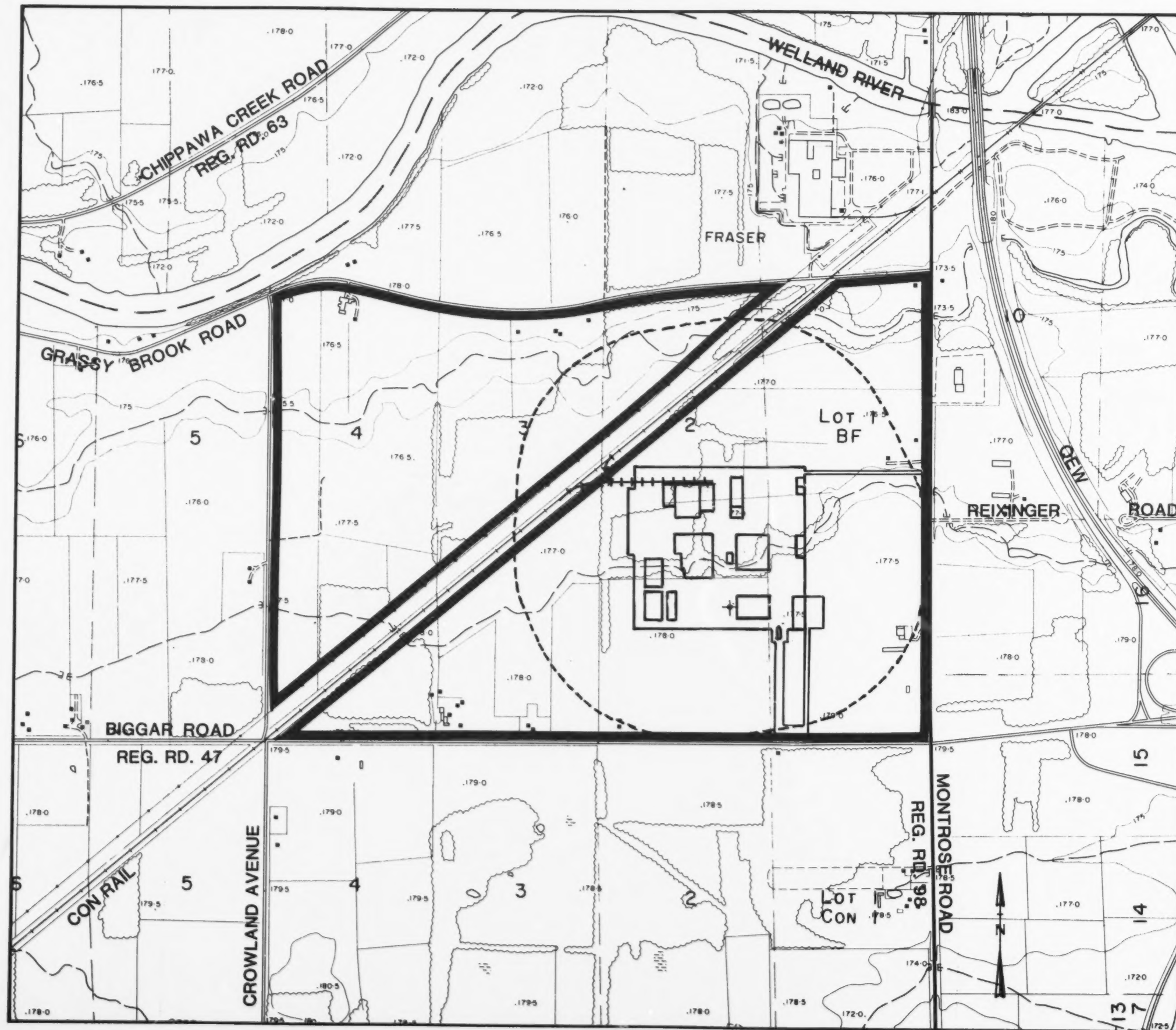
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
LF-1E**

December 1985

FIGURE D.20



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

PI-27 East

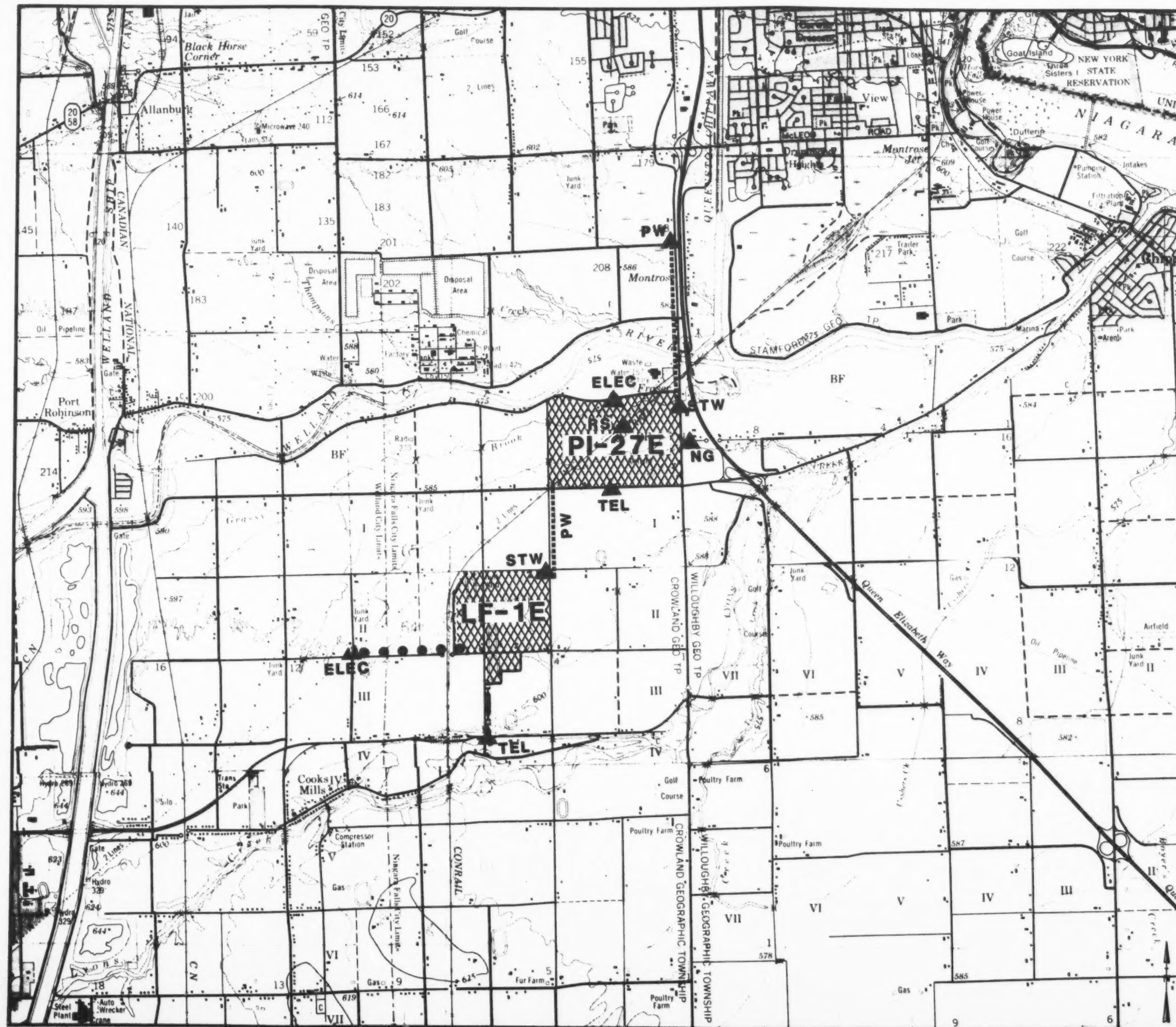
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 2-
LANDFILL SEPARATE
PI-27E**

December 1985

FIGURE D.21



Legend:

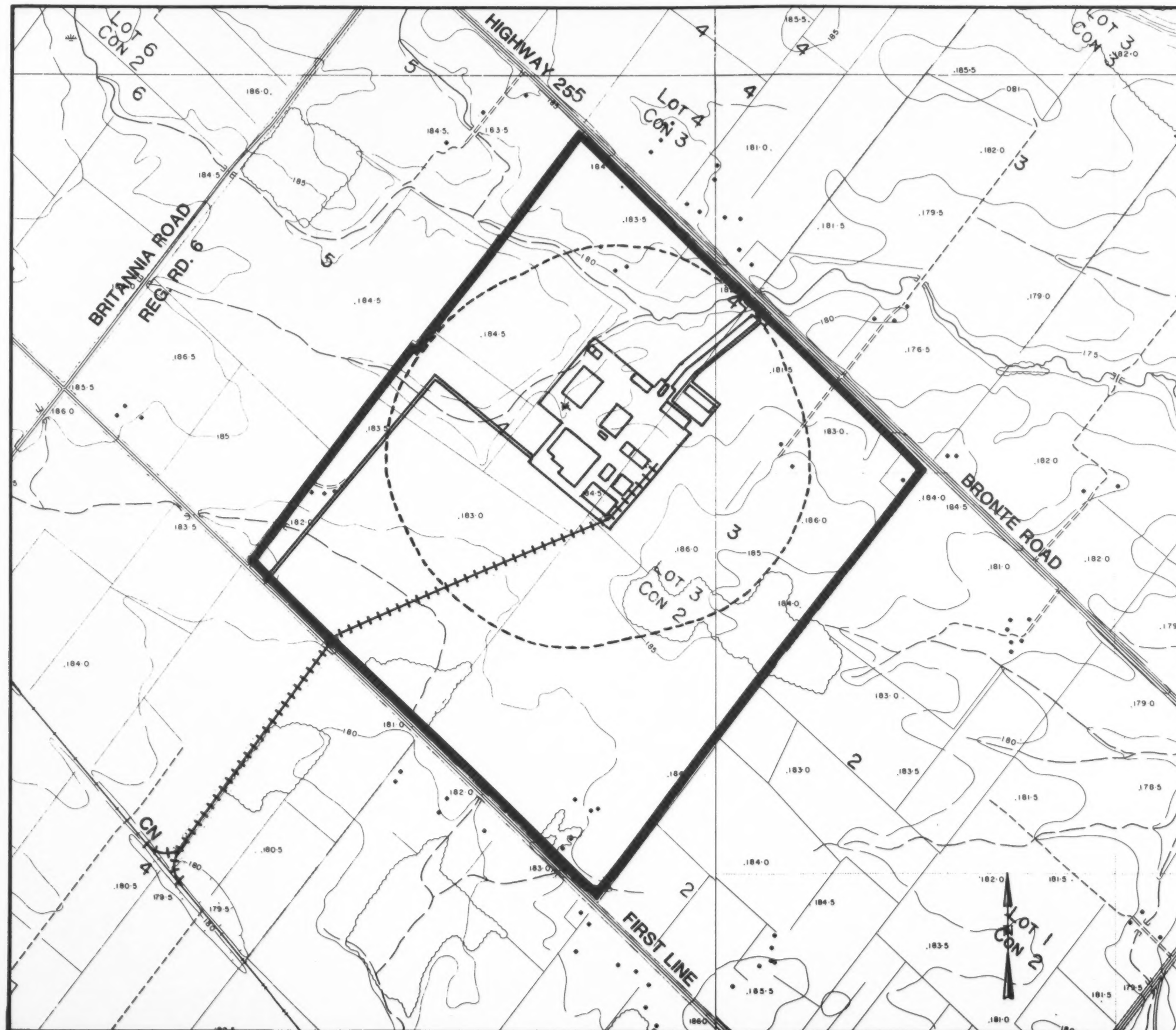
Symbol	Abbreviation	Description
---	STW	Clean Stormwater
- - - - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆ ◆ ◆ ◆ ◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1mile
0 1Kilometre
1:50 000

SERVICE CONNECTIONS
CASE 2-
LANDFILL SEPARATE
LF-1E/PI-27E

December 1985

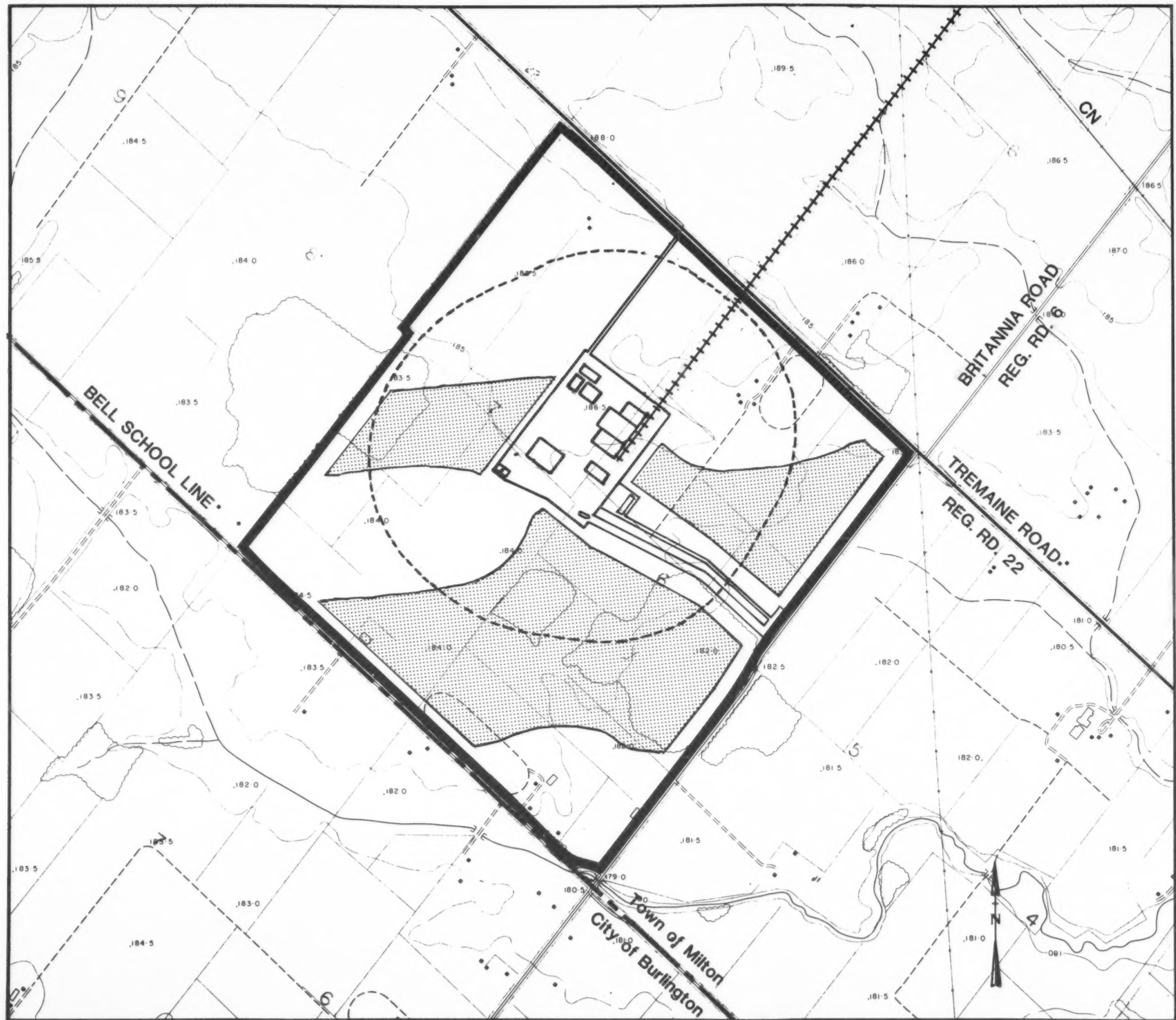
FIGURE D.22



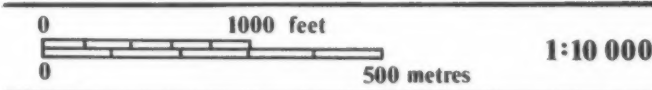
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



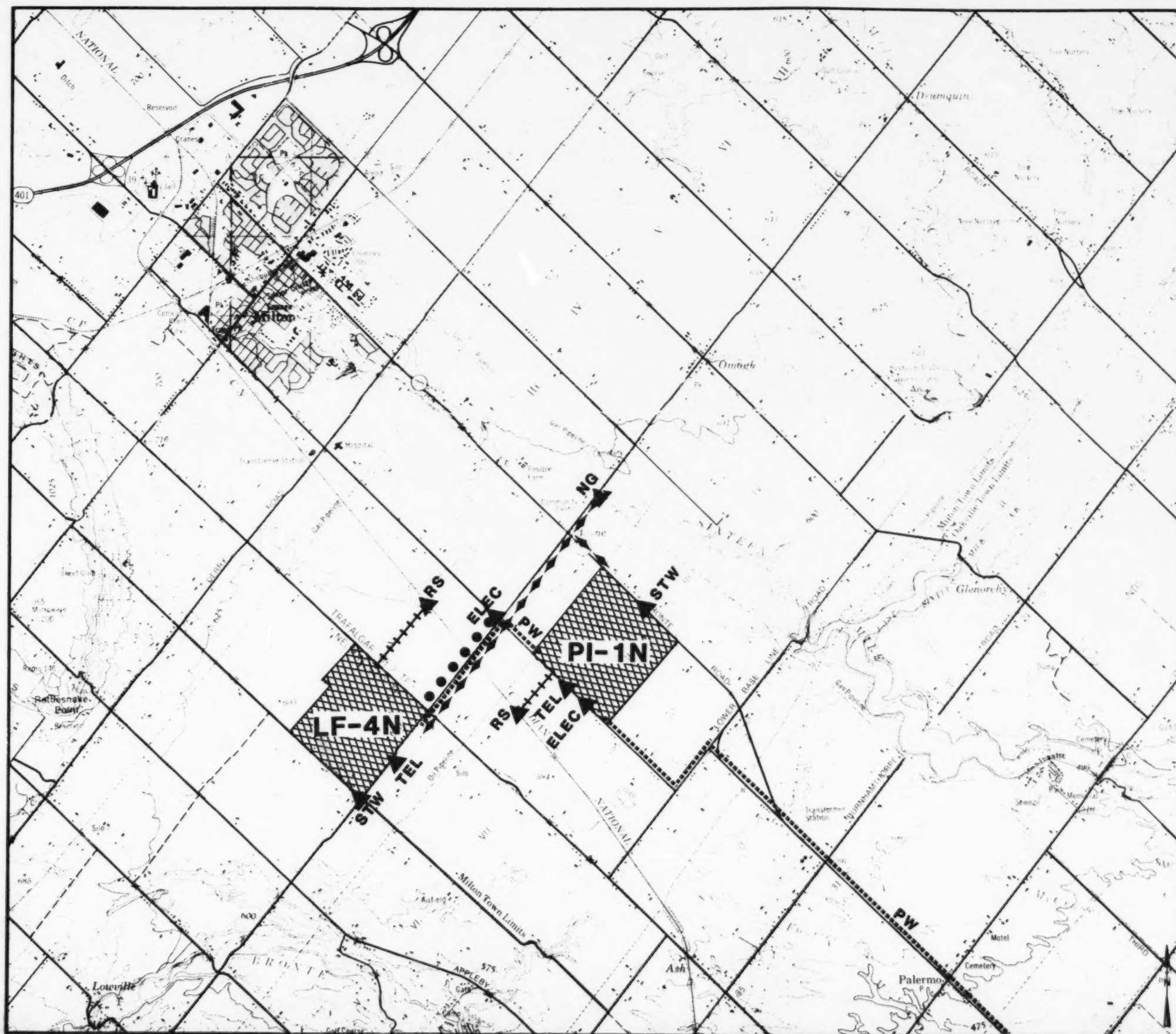
SITE LAYOUT
CASE 3-
INCINERATOR SEPARATE
PI-1N



Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



SITE LAYOUT
CASE 3-
INCINERATOR SEPARATE
LF-4N



Legend:

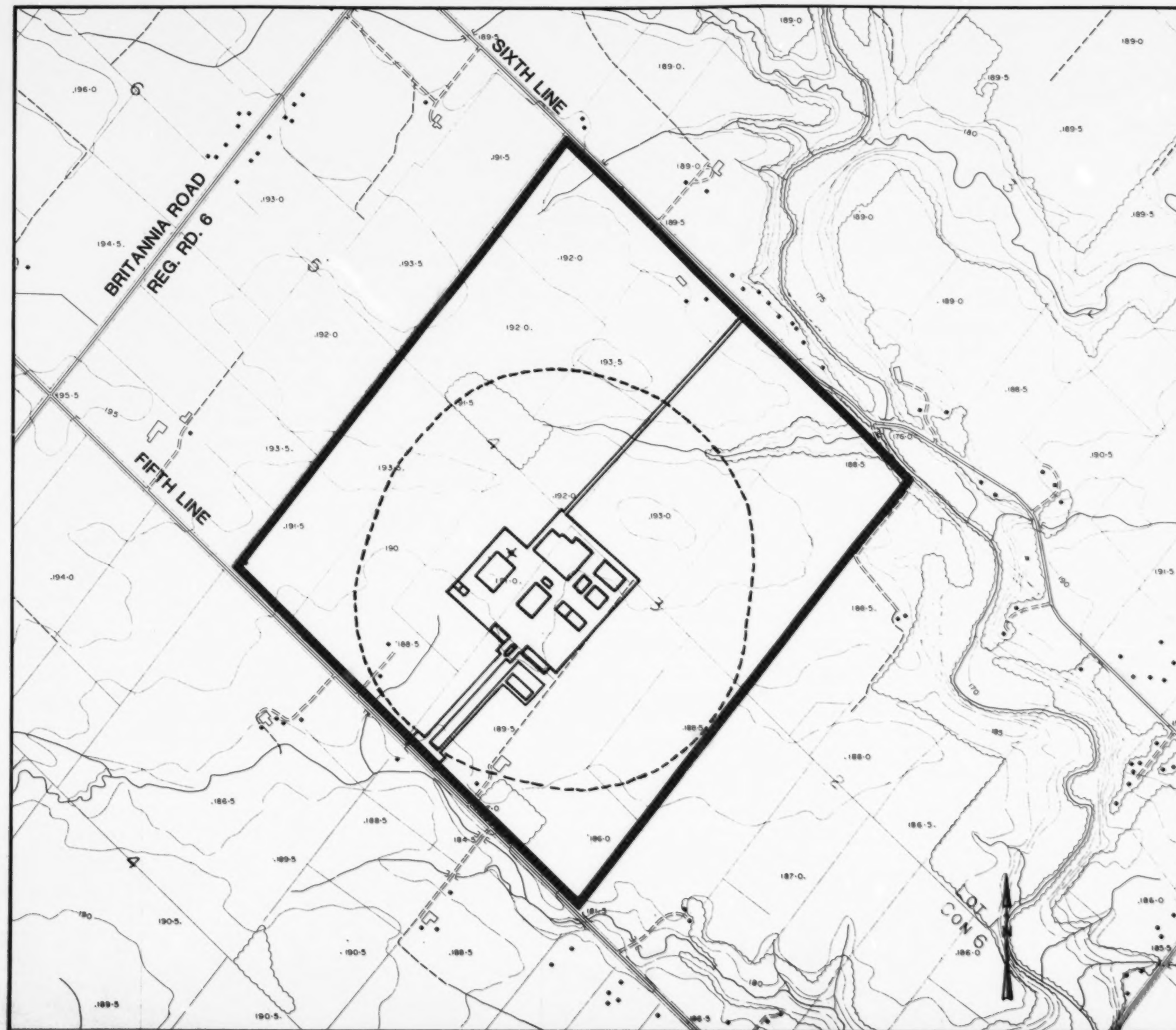
Symbol	Abbreviation	Description
—	STW	Clean Stormwater
- - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ●	ELEC	Electric Power Supply
—●—●—●—●—	TEL	Telephone
◆◆◆◆◆	NG	Natural Gas Supply
+ + + + +	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1:50 000

**SERVICE CONNECTIONS
CASE 3-
INCINERATOR SEPARATE
PI-1N/LF-4N**

December 1985

FIGURE D.25



OWMC Ontario Waste Management Corporation

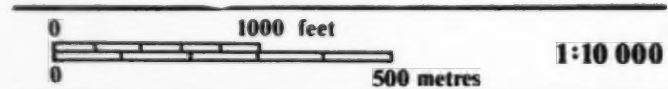
Consultant

Monenco

Legend:

PI-13 North

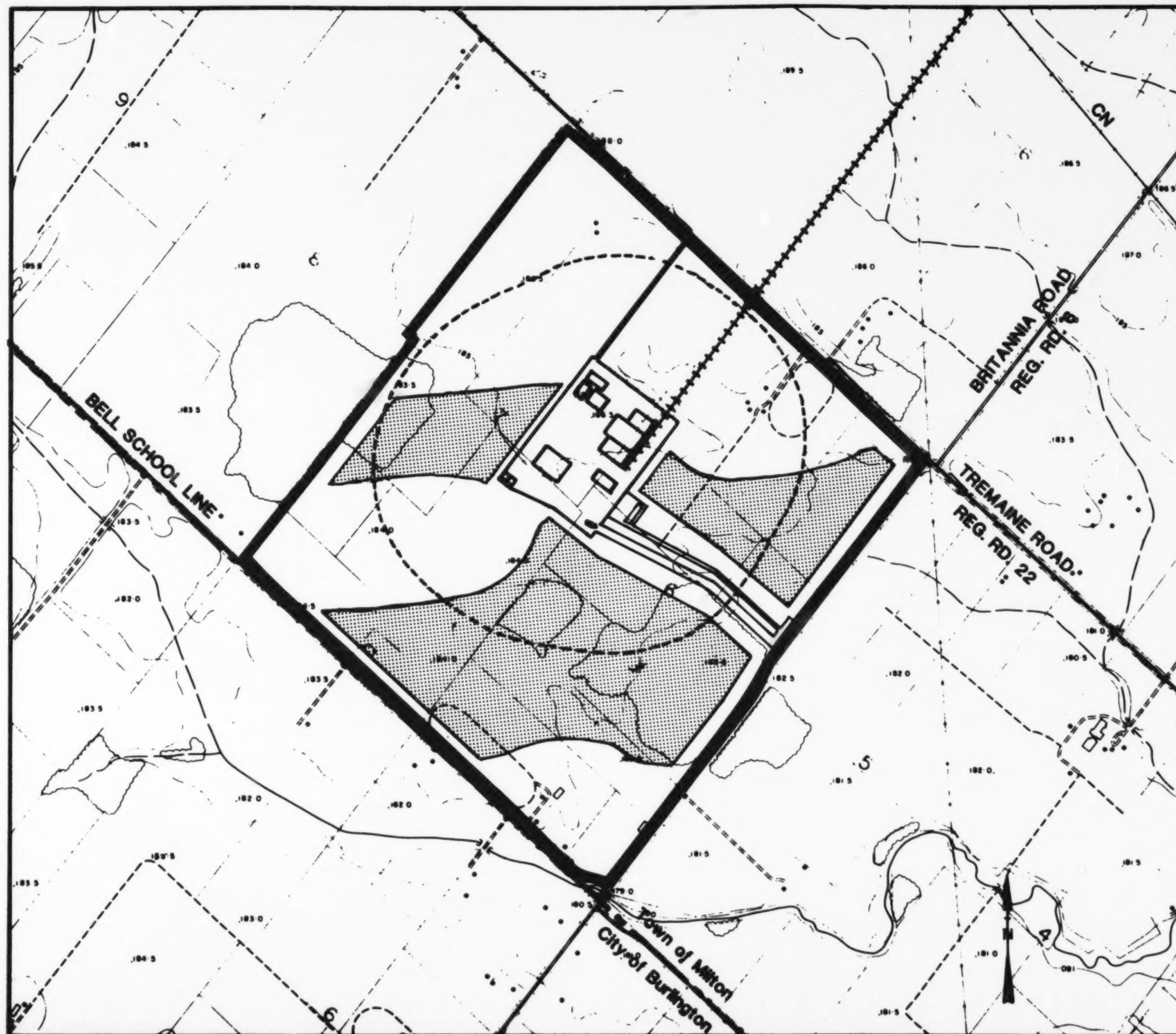
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



SITE LAYOUT
CASE 3-
INCINERATOR SEPARATE
PI-13N

December 1985

FIGURE D.26



OWMC Ontario Waste Management Corporation

Consultant

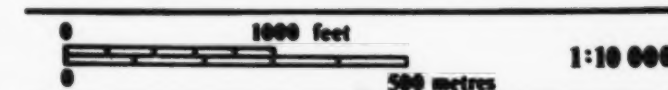


Monenco

Legend:

LF - 4North

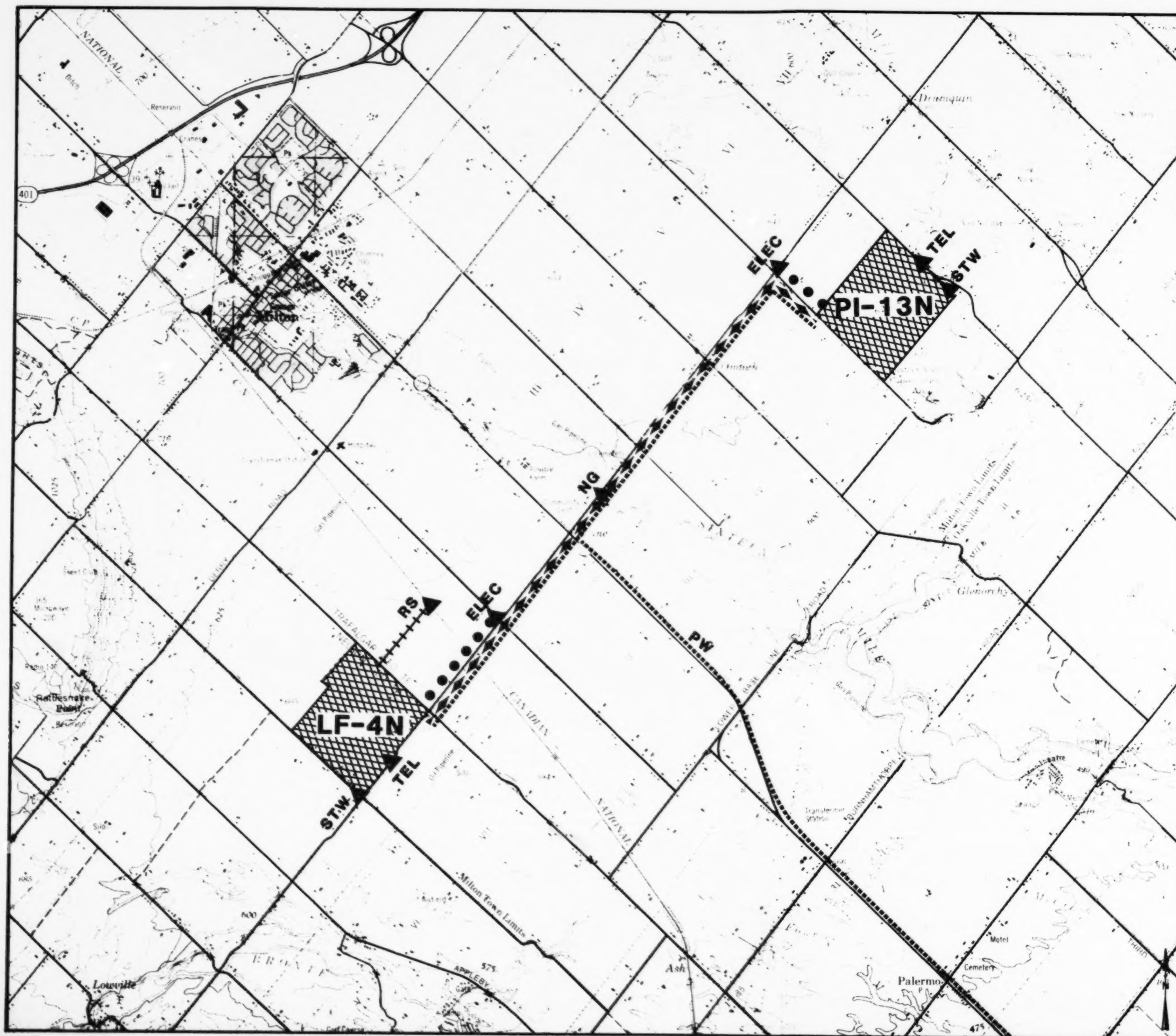
Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 3-
INCINERATOR SEPARATE
LF-4N**

December 1985

FIGURE D.27



OWMC Ontario Waste Management Corporation

Consultant

Monenco

Legend:

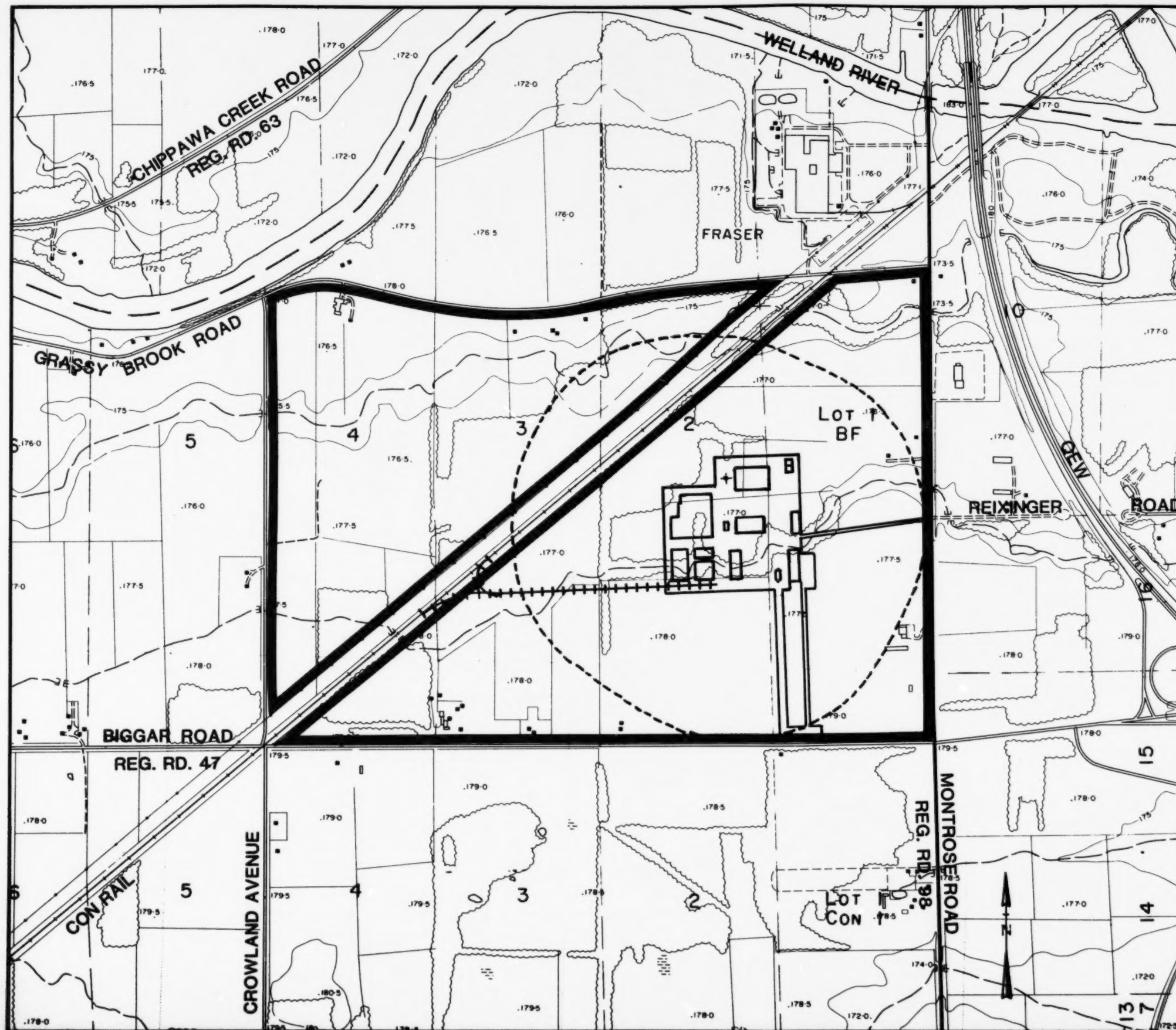
Symbol	Abbreviation	Description
— — — — —	STW	Clean Stormwater
- - - - -	RW	Raw Water Supply
.....	PW	Potable Water Supply
● ● ● ● ●	ELEC	Electric Power Supply
— — — — —	TEL	Telephone
◆ ◆ ◆ ◆ ◆	NG	Natural Gas Supply
— + — + — + — + — + —	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1: 50 000

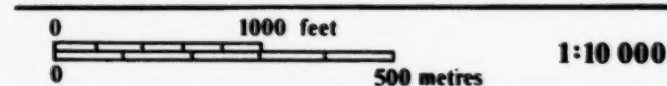
SERVICE CONNECTIONS
CASE 3
INCINERATOR SEPARATE
PI-13N / LF-4N

December 1985

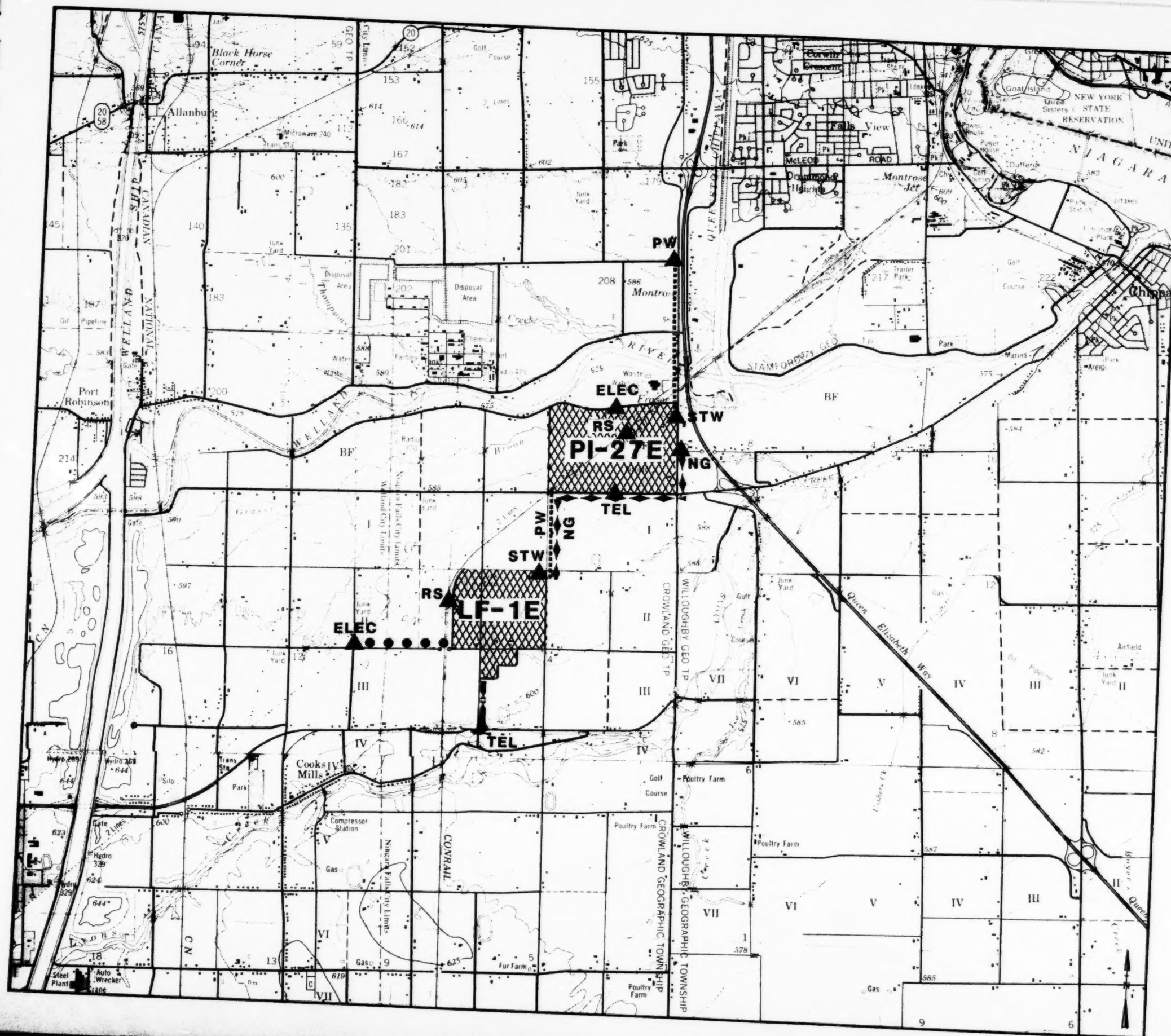
FIGURE D.28



Symbol	Description
	Acquisition Boundary
	Landfill Area
	Technical Buffer Zone
	Rail Spur



**SITE LAYOUT
CASE 3-
INCINERATOR SEPARATE
PI-27E**



OWMC Ontario
Waste Management
Corporation

Consultant

Monenco

Legend:

Symbol	Abbreviation	Description
---	STW	Clean Stormwater
---	RW	Raw Water Supply
---	PW	Potable Water Supply
●●●●	ELEC	Electric Power Supply
—◆—◆—◆—◆—◆—◆—	TEL	Telephone
—◆—◆—◆—◆—◆—◆—	NG	Natural Gas Supply
+++++	RS	Rail Spur
▲		Service Tie-in
▨		Candidate Site

0 1 mile
0 1 Kilometre
1:50 000

**SERVICE CONNECTIONS
CASE 3
INCINERATOR SEPARATE
PI-27E/LF-1E**

December 1985

FIGURE D.31

APPENDIX E
ESTIMATE DETAIL SHEETS

TABLE E.1

CAPITAL COST ESTIMATE - 150 000 t/a CAPACITY
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE				CASE 3 - INCINERATOR SEPARATE			
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	PI-1N/ LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E		
SITE	ENGINEERING	CAPITAL COST	INCINERATION	34311	34311	34311	34311	34311	34311	34311	34311	34311	34311	34311
			PHYSICAL/CHEMICAL TREATMENT	28120	28120	28120	28120	28120	28120	28120	28120	28120	28120	28120
			SOLIDIFICATION	7403	7403	7403	7403	7403	7403	7403	7403	7403	7403	7403
			ON-SITE FACILITIES	50153	50153	50153	50153	50153	50153	69961	69961	69961	69961	69961
			ENGINEERED LANDFILL	5866	6065	7215	5368	5368	6997	5552	5552	7201	7201	7201
			ON-SITE FACILITIES (SITE SPECIFIC)	11831	9120	9179	11788	11322	12065	8877	8411	12125	12125	12125
			OFF-SITE FACILITIES	2371	2006	3490	2871	4467	3090	2899	4495	3228	3228	3228
		TOTAL ESTIMATED COST	140055	137178	139871	140014	141144	142139	157123	158253	162349	162349		

Note: All costs shown in 1984 thousand dollars (Canadian).

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.2

CAPITAL COST ESTIMATE - 300 000 t/a CAPACITY
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE				CASE 3 - INCINERATOR SEPARATE			
SITE	ENGINEERING	CAPITAL COST	INCINERATION	LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	PI-1N/ LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E		
				56031	56031	56031	56031	56031	56031	56031	56031	56031	56031	56031
				46836	46836	46836	46836	46836	46836	46836	46836	46836	46836	46836
				11808	11808	11808	11808	11808	11808	11808	11808	11808	11808	11808
				55509	55509	55509	55509	55509	55509	55509	74881	74881	74881	74881
				5866	6065	7215	5368	5368	6997	5552	5552	7201	5552	7201
				13664	11278	11177	11959	11493	13731	9020	8554	13758	8554	13758
				2371	2006	3490	2871	4467	3090	2899	4495	3228	4495	3228
			TOTAL ESTIMATED COST	192084	189533	192066	190382	191512	194002	207027	208157	213743		

Site: All costs shown in 1984 thousands of dollars.

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.3

OPERATING COST ESTIMATE - YEAR 5 OPERATING COSTS
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE				CASE 3 - INCINERATOR SEPARATE			
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	PI-1N/ LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E		
SITE	ENGINEERING	OPERATING COST	FIXED OPERATING COSTS:											
			• GENERAL ADMINISTRATION, TAXES AND INSURANCE	5597	5487	5595	5601	5646	5686	6285	6330	6494		
			• MAINTENANCE	4003	3909	3918	3932	3979	3883	4437	4484	4478		
			VARIABLE OPERATING COSTS:											
			• OPERATING LABOUR	3176	3176	3176	3176	3176	3176	3322	3322	3322		
			• UTILITIES	1794	1794	1561	1681	1681	1561	2323	2323	2323		
			• ADDITIVES AND REAGENTS	6819	6819	6814	6814	6814	6814	6814	6814	6814		
			• ENGINEERED LANDFILL	1874	1885	3098	1378	1378	2949	1530	1530	3098		
			• TRANSPORTATION											
			• SPECIAL WASTE	2037	2236	2265	1946	1932	2183	1979	1977	2248		
			• INTERSITE TRANSFERS	-	-	-	628	723	628	88	101	88		
			• ADDITIVES AND REAGENTS	657	702	731	370	364	716	377	376	729		
			TOTAL	25957	26008	27158	25526	25693	27596	27155	27257	29553		

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.4

OPERATING COST ESTIMATE - YEAR 10 OPERATING COSTS
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE				CASE 3 - INCINERATOR SEPARATE			
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	PI-1N/ LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E		
SITE	ENGINEERING	OPERATING COST	FIXED OPERATING COSTS:											
			• GENERAL ADMINISTRATION, TAXES AND INSURANCE	7678	7581	7683	7615	7660	7660	8281	8326	8549		
			• MAINTENANCE	5564	5480	5484	5443	5490	5439	5934	5981	6019		
			VARIABLE OPERATING COSTS:											
			• OPERATING LABOUR	4818	4818	4818	4818	4818	4818	4964	4964	4964		
			• UTILITIES	2196	2196	2084	2261	2261	2084	3192	3192	2991		
			• ADDITIVES AND REAGENTS	13637	13637	13627	13627	13627	13627	13627	13627	13627		
			• ENGINEERED LANDFILL	3219	3241	5666	2643	2643	5616	2693	2693	5666		
		TRANSPORTATION • SPECIAL WASTE • INTERSITE TRANSFERS • ADDITIVES AND REAGENTS	• TRANSPORTATION	4073	4472	4530	3891	3864	4366	3957	3954	4196		
			• SPECIAL WASTE	-	-	-	1256	1446	1256	175	201	175		
			• INTERSITE	-	-	-	1256	1446	1256	175	201	175		
			• ADDITIVES AND	1315	1403	1462	741	727	1432	755	753	1459		
			• REAGENTS	42500	42828	45354	42295	42536	46398	43578	43691	47946		
		TOTAL		42500	42828	45354	42295	42536	46398	43578	43691	47946		

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.5

OPERATING COST ESTIMATE - START-UP, DECOMMISSIONING AND POST CLOSURE
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE			CASE 3 - INCINERATOR SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	PI-1N/ LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E
SITE	ENGINEERING	OPERATING COST	START-UP COSTS:									
			• YEAR -1	3600	3600	3600	3600	3600	3600	3600	3600	3600
			• YEAR 1	4345	4418	4364	4385	4407	4523	4471	4474	4645
			• YEAR 6	3259	3314	3273	3289	3305	3392	3353	3356	3484
			DECOMMISSIONING COSTS	14700	14700	14700	14700	14700	14700	17400	17400	17400
			POST CLOSURE AND LONG TERM CARE:									
			• ANNUAL MONITORING & MAINTENANCE	200	200	200	200	200	200	300	300	300

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.6

ANNUAL OPERATING COSTS
TOTAL SOLIDIFICATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE			CASE 3 - INCINERATOR SEPARATE				
SITE	ENGINEERING	OPERATING COST SUMMARY	YEAR -1	LF-9C	LF-3C	LF-1E	LF-4N PI-1N	LF-4N PI-13N	LF-1E PI-27E	PI-1N LF-4N	PI-13N/ LF-4N	PI-27E/ LF-1E		
				3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
				20479	20429	20191	20265	20397	20585	22154	22253	22746		
				18851	18773	19827	18291	18409	20107	20055	20152	22127		
				22105	22083	23179	21580	21711	23505	23343	23442	25557		
				24137	24156	25283	23707	23847	25713	25336	25437	27654		
				25957	26008	27158	25607	25774	27596	27236	27338	29553		
				34726	34903	36064	34385	34382	36705	36252	36359	38894		
				35174	35356	37791	34741	34937	38544	36330	36436	40445		
				37411	37641	40106	37130	37341	41033	38553	38662	62786		
				40153	40434	42928	39848	40074	43851	41192	41303	45544		
				42500	42828	45354	42295	42536	46398	43578	43691	47946		
				14900	14900	14900	14900	14900	14900	17700	17700	17700		
200	200	200	200	200	200	300	300	300						

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.7

CAPITAL COST ESTIMATE - 150 000 t/a CAPACITY
 PARTIAL SOLIDIFICATION WITH EVAPORATION
 COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E
SITE	ENGINEERING	CAPITAL COST	INCINERATION	37108	37108	37108	37108	37108	37108
			PHYSICAL/CHEMICAL TREATMENT	28120	28120	28120	28120	28120	28120
			SOLIDIFICATION	7403	7403	7403	7403	7403	7403
			ON-SITE FACILITIES	52329	52329	52329	52329	52329	52329
			ENGINEERED LANDFILL	5008	5207	5731	4691	4691	5513
			ON-SITE FACILITIES (SITE SPECIFIC)	11650	8931	8351	11426	10960	11156
			OFF-SITE FACILITIES	2371	2006	3490	2871	4467	3090
			TOTAL ESTIMATED COST	143989	141104	142532	143948	145078	144719

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.8

CAPITAL COST ESTIMATE - 300 000 t/a CAPACITY
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE			
				LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	
SITE	ENGINEERING	CAPITAL COST	INCINERATION	58828	58828	58828	58828	58828	58828	58828
			PHYSICAL/CHEMICAL TREATMENT	46836	46836	46836	46836	46836	46836	
			SOLIDIFICATION	11808	11808	11808	11808	11808	11808	
			ON-SITE FACILITIES	58519	58519	58519	58519	58519	58519	
			ENGINEERED LANDFILL	5008	5207	5731	4691	4691	5513	
			ON-SITE FACILITIES (SITE SPECIFIC)	13483	11089	10349	11597	11131	12822	
		OFF-SITE FACILITIES	2371	2006	3490	2871	4467	3090		
			TOTAL ESTIMATED COST	196853	194293	195561	195150	196280	197415	

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.9

OPERATING COST ESTIMATE - YEAR 5 OPERATING COSTS
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE			
SITE	ENGINEERING	OPERATING COST	FIXED OPERATING COSTS:	LF-9C	LF-3C	LF-1E	LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	
			• GENERAL ADMINISTRATION, TAXES AND INSURANCE	5755	5644	5701	5758	5803	5789	
			• MAINTENANCE	4153	4058	4100	4081	4128	4032	
			VARIABLE OPERATING COSTS:							
			• OPERATING LABOUR	3322	3322	3322	3322	3322	3322	
			• UTILITIES	4006	4006	2784	2946	2946	2784	
			• ADDITIVES AND REAGENTS	3545	3545	3540	3540	3540	3540	
			• ENGINEERED LANDFILL	1124	1133	1672	844	844	1486	
			• TRANSPORTATION							
			• SPECIAL WASTE	2037	2236	2265	1946	1932	2184	
			• INTERSITE TRANSFERS	-	-	-	300	347	300	
			• ADDITIVES AND REAGENTS	378	399	413	248	244	406	
			TOTAL	24320	24343	23797	22985	23106	23843	

Notes: All costs shown in 1984 thousand dollars (Canadian)

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.10

OPERATING COST ESTIMATE - YEAR 10 OPERATING COSTS
 PARTIAL SOLIDIFICATION WITH EVAPORATION
 COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N/PI-1N	LF-4N/PI-13N	LF-1E/PI-27E
SITE	ENGINEERING	OPERATING COST	FIXED OPERATING COSTS:						
			• GENERAL ADMINISTRATION, TAXES AND INSURANCE	7869	7772	7822	7806	7851	7897
			• MAINTENANCE	5739	5654	5658	5618	5665	5613
			VARIABLE OPERATING COSTS:						
			• OPERATING LABOUR	4964	4964	4964	4964	4964	4964
			• UTILITIES	5984	5984	4159	4399	4399	4159
			• ADDITIVES AND REAGENTS	7090	7090	7080	7080	7080	7080
			• ENGINEERED LANDFILL	1855	1873	2951	1531	1531	2815
			• TRANSPORTATION						
			• SPECIAL WASTE	4073	4472	4530	3891	3864	4366
			• INTERSITE TRANSFERS	-	-	-	601	691	601
			• ADDITIVES AND REAGENTS	757	798	825	496	489	812
			TOTAL	38331	38607	37989	36386	36534	38307

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.11

OPERATING COST ESTIMATE - START-UP, DECOMMISSIONING AND POST CLOSURE
 PARTIAL SOLIDIFICATION WITH EVAPORATION
 COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED				CASE 2 - LANDFILL SEPARATE			
				LF-9C	LF-3C	LF-1E		LF-4N/ PI-1N	LF-4N/ PI-13N	LF-1E/ PI-27E	
SITE	ENGINEERING	OPERATING COST	START-UP COSTS:								
			• YEAR -1	3600	3600	3600		3600	3600	3600	
			• YEAR 1	3986	4032	3697		3691	3699	3761	
			• YEAR 6	2990	3039	2773		2768	2774	2822	
			DECOMMISSIONING COSTS	14700	14700	14700		14700	14700	14700	
			POST CLOSURE AND LONG TERM CARE:								
			• ANNUAL MONITORING & MAINTENANCE	200	200	200		200	200	200	

Note: All costs shown in 1984 thousand dollars (Canadian).

TABLE E.12

ANNUAL OPERATING COSTS
PARTIAL SOLIDIFICATION WITH EVAPORATION
COMPARATIVE EVALUATION OF SITING OPTIONS

STUDY AREA	FACTOR GROUPING	FACTORS	INDICATORS	CASE 1 - INTEGRATED			CASE 2 - LANDFILL SEPARATE		
				LF-9C	LF-3C	LF-1E	LF-4N PI-1N	LF-4N PI-13N	LF-1E PI-27E
SITE	ENGINEERING	OPERATING COST SUMMARY	YEAR -1	3600	3600	3600	3600	3600	3600
			1	20304	20237	19346	19345	19449	19468
			2	18175	18081	17969	17303	17409	18031
			3	21046	21003	20702	19974	20086	20759
			4	22818	22813	22373	21644	21762	22470
			5	24320	24343	23797	22985	23106	23843
			6	32617	32757	31910	30955	31088	32069
			7	32244	32403	32207	30709	30841	32468
			8	34151	34339	34909	32494	32642	34320
			9	36361	36593	36119	34524	34667	36397
			10 - 20	38331	38607	37989	36386	36534	38307
			21	14900	14900	14900	14900	14900	14900
			22	200	200	200	200	200	200

Note: All costs shown in 1984 thousand dollars (Canadian).